SBIR

Small Business Innovation Research

for FY 1999

DOC PROGRAM SOLICITATION

http://www.oar.noaa.gov/ORTA/SBIR

Closing Date: January 13, 1999

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U.S. DEPARTMENT OF COMMERCE

PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Department of Commerce (DOC) invites small businesses to submit research proposals under this solicitation. Firms with strong research capabilities in any of the areas listed in Section 8 of this solicitation are encouraged to participate. **Unsolicited proposals are not accepted under the Small Business Innovation Research (SBIR) program**.

Objectives of this program include stimulating technological innovation in the private sector and strengthening the role of small business in meeting Federal research and development (R&D) needs. This program also seeks to increase the commercial application of innovations derived from Federal research and improve the return on investment from Federally-funded research for the economic benefit of the Nation.

1.2 Three-Phase Program

The "Small Business Research and Development Enhancement Act of 1992" requires the Department of Commerce to establish a three-phase SBIR program by reserving a percentage of its extramural R&D budget to be awarded to small business concerns for innovation research.

The funding vehicles for DOC's SBIR program in both Phase 1 and Phase 2 are contracts. This document solicits Phase 1 proposals only.

DOC has the unilateral right to select SBIR research topics and awardees in both Phase 1 and Phase 2, and to award several or no contracts under a given topic.

1.2.1 Phase 1 - Feasibility Research

The purpose of Phase 1 is to determine the technical feasibility of the proposed research and the quality of performance of the small business concern receiving an award. Therefore, the proposal should concentrate on research that will significantly contribute to proving the feasibility of the proposed research, a prerequisite to further support in Phase 2.

1.2.2 Phase 2 - Research and Development

Only firms that are awarded Phase 1 contracts under this solicitation will be given the opportunity of submitting a Phase 2 proposal immediately following completion of Phase 1.

Phase 2 is the R&D or prototype development phase. It will require a comprehensive proposal outlining the research in detail. Further information regarding Phase 2 proposal requirements will be provided to all firms receiving Phase 1 contracts.

1.2.3 Phase 3 - Commercialization

In Phase 3, it is intended that non-SBIR capital be used by the small business to pursue commercial applications of Phase 2.

1.3 Eligibility

Each organization submitting a proposal **must** qualify as a small business (Section 2.1) for research or R&D purposes (Section 2.2).
In addition, the primary employment of the principal investigator must be with the small business at the time of the award. More than one-half of the principal investigator's time must be spent with the small business for the period covered by the award. **Primary employment with a small business precludes full-time employment with another organization.**

Also, for both Phase 1 and Phase 2, the work must be performed in the United States. "United States" means the fifty states, the territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are eligible, provided the entity created qualifies as a small business as defined in this solicitation. **Consultative arrangements between firms and universities or other non-profit organizations are encouraged, with the small business serving as the prime contractor.**

1.4 Contact with DOC

In the interest of competitive fairness, oral or written communication with DOC or any of its components concerning additional information on the technical topics described in Section 8 of this solicitation **is prohibited**.

Requests for general information on the DOC SBIR program may be addressed to:

Dr. Joseph M. Bishop
DOC SBIR Program Manager
1315 East-West Highway
Silver Spring, MD 20910
Telephone: (301) 713-3565
Fax: (301) 713-4100
E-mail: joseph.bishop@noaa.gov

or

Mr. Norman Taylor
NIST SBIR Program Manager
Building 820, Room 306
Gaithersburg, MD 20899
Telephone: (301) 975-4517
Fax: (301) 548-0624
E-mail: norman.taylor@nist.gov

Information sources and/or document services are listed in Section 7.

2.0 DEFINITIONS

2.1 Small Business

A small business concern is one that, at the time of award for Phase 1 and Phase 2:

(a) is independently owned and operated, is organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States (Section 1.3);

(b) is at least 51 percent owned, or in the case of a publicly owned business, at least 51 percent of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens; and

(c) has, including its affiliates, a number of employees not exceeding 500, and meets the other small business regulatory requirements found in 13 Code of Federal Regulations Part 121. Business concerns are affiliates of one another when, either directly or indirectly, (1) one concern controls or has the power to control the other, or (2) a third party controls both. Control can be exercised through common ownership, common management, and contractual relationships. Business concerns include, but are not limited to, any individual, partnership, joint venture, association, or cooperative.

2.2 Research or Research and Development

Any activity that is (a) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (b) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (c) a systematic application of knowledge toward the production of useful materials, devices, services, or methods, and includes design, development, and improvement of prototypes and new processes to meet specific requirements.

In general, the DOC SBIR program will fund Phase 1 and 2 proposals with objectives that can be defined by (b) and (c) above.

2.3 Socially and Economically Disadvantaged Small Business Concern

Is one that is:

(a) at least 51 percent owned by (1) an American Indian tribe or a native Hawaiian organization, or (2) one or more socially and economically disadvantaged individuals, and

(b) controlled by one or more such individuals in its management and daily business operations.

A socially and economically disadvantaged individual is defined as a member of any of the

following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, or any other individual found to be socially and economically disadvantaged by the Small Business Administration (SBA) pursuant to Section 8(a) of the Small Business Act, 15 U.S. Code (U.S.C.) 637(a).

2.4 Women-Owned Small Business

A small business that is at least 51 percent owned by a woman or women who also control (meaning to exercise the power to make policy decisions) and operate (meaning being actively involved in the day-to-day management) the small business.

2.5 Subcontract

This is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government funding awardee, calling for supplies or services required solely for the performance of the original funding agreement.

2.6 Commercialization

This is locating or developing markets and producing and delivering products for sale (whether by the originating party or by others). As used here, commercialization includes both Government and private sector markets.

3.0 PROPOSAL PREPARATION

3.1 Proposal Requirements

The objective is to provide sufficient information to demonstrate that the proposed work represents a sound approach to the investigation of an important scientific or engineering innovation worthy of support. **The proposal must meet all the requirements of the subtopic in Section 8 to which it applies**.

A proposal must be self-contained and written with all the care and thoroughness of a scientific paper submitted for publication. It should indicate a thorough knowledge of the current status of research in the subtopic area addressed by the proposal. Each proposal should be checked carefully by the offeror to ensure inclusion of all essential material needed for a complete evaluation. The proposal will be peer reviewed as a scientific paper (all units of measurement should be in the metric system).

DOC reserves the right not to submit to technical review any proposal which it finds to have insufficient scientific and technical information, or one which fails to comply with the administrative procedures as outlined on the Checklist of Requirements in Section 9.

The proposal must not only be responsive to the specific DOC program interests described in Section 8 of the solicitation, but also serve as the basis for technological innovation leading to new commercial products, processes, or services that benefit the public. An organization may submit different proposals on different subtopics or different proposals on the same subtopic under this solicitation. When the proposed innovation applies to more than one subtopic, the offeror must choose that subtopic which is most relevant to the offeror's technical concept.

Proposals principally for the commercialization of proven concepts or for market research must not be submitted for Phase 1 funding, since such efforts are considered the responsibility of the private sector.

The proposal should be direct, concise, and informative. Promotional and other material not related to the project shall be omitted. **The Phase 1 proposal must provide a description of potential commercial applications.**

3.2 Phase 1 Proposal Limitations

- **!** Page Length - **no more than 25 pages**, consecutively numbered, including the cover page, project summary, main text, references, resumes, any other enclosures or attachments, and the proposal summary budget.
- **!** Paper Size - must be 21.6 cm X 27.9 cm (8 ½" X 11").
- **!** Print Size - **must be easy to read with a fixed pitch font of 12 or fewer characters per inch or proportionally spaced font of point size 10 or larger with no more than 6 lines per inch.**

Supplementary material, revisions, substitutions, audio or video tapes, or computer floppy disks will **not** be accepted.

Proposals not meeting these requirements will be returned without review.

3.3 Phase 1 Proposal Format

3.3.1 Cover Sheet

Complete Section 9 "Cover Page" as page 1 of each copy of each proposal. **NO OTHER COVER WILL BE ACCEPTED.** Xerox copies are permitted.

3.3.2 Project Summary

Complete Section 9 "Project Summary" as page 2 of your proposal. The technical abstract should include a brief description of the problem or opportunity, the innovation, project objectives, and technical approach.

In summarizing anticipated results, include technical implications of the approach (for both Phase 1 and 2) and the potential commercial applications of the research. **The Project Summary of proposals that received an award will be published by DOC and, therefore, must not contain proprietary information.**

3.3.3 Technical Content

Beginning on page 3 of the proposal, include the following items with headings as shown:

(a) **Identification and Significance of the Problem or Opportunity.** Make a clear statement of the specific research problem or opportunity addressed, its innovativeness, commercial potential, and why it is important. Show how it applies to a specific subtopic in Section 8.

(b) **Phase 1 Technical Objectives.** State the specific objectives of the Phase 1 effort, including the technical questions it will try to answer, to determine the feasibility of the proposed approach.

(c) **Phase 1 Work Plan.** Include a detailed description of the Phase 1 R&D plan. The plan should indicate not only what will be done, but where it will be done, and how the R&D will be carried out. The methods planned to achieve each objective or task should be discussed in detail. **This section should be at least one-third of the proposal.**

(d) **Related Research or R&D.** Describe research or R&D that is directly related to the proposal, including any conducted by the principal investigator or by the proposer's firm. Describe how it relates to the proposed effort, and describe any planned coordination with outside sources. The purpose of this section is to persuade reviewers of the proposer's awareness of recent developments in the specific topic area.

(e) **Key Personnel and Bibliography of Related Work.** Identify key personnel involved in Phase 1, including their related education, experience, and publications. Where resumes are extensive, summaries that focus on the most relevant experience and publications are suggested. List all other commitments that key personnel have during the proposed period of contract performance.

(f) **Relationship with Future R&D.** Discuss the significance of the Phase 1 effort in providing a foundation for the Phase 2 R&D effort. Also state the anticipated results of the proposed approach, if Phases 1 and 2 of the project are successful.

(g) **Facilities and Equipment.** The conduct of advanced research may require the use of sophisticated instrumentation or computer facilities. The proposer should

provide a detailed description of the availability and location of the facilities and equipment necessary to carry out Phase 1.

(h) **Consultants and Subcontracts.** The purpose of this section is to convince DOC that: (1) research assistance from outside the firm materially benefits the proposed effort, and (2) arrangements for such assistance are in place at the time the proposal is submitted.

Outside involvement in the project is encouraged where it strengthens the conduct of the research; such involvement is not a requirement of this solicitation.

1. Consultant - A person outside the firm, named in the proposal as contributing to the research, must provide a signed statement confirming his/her availability, role in the project, and agreed consulting rate for participation in the project. *This statement is part of the page count.*

2. Subcontract - Similarly, where a subcontract is involved in the research, the subcontracting institution must furnish a letter signed by an appropriate official describing the programmatic arrangements and confirming its agreed participation in the research, with its proposed budget for this participation. *This letter is part of the page count.*

(i) **Potential Commercial Application and Follow-on Funding Commitment.** Describe in detail the commercial potential of the proposed research, how commercialization would be pursued, and potential use by the Federal Government.

(j) **Cooperative Research and Development Agreements (CRADA).** State if the applicant is a current CRADA partner with DOC, or with any other Federal agency, naming the agency, title of the CRADA, and any relationship with the proposed work.

(k) **Guest Researcher.** State if the applicant is a guest researcher at DOC, naming the sponsoring laboratory.

3.4 Equivalent Proposals or Awards

A firm may have received other SBIR awards or elected to submit essentially equivalent proposals under other SBIR program solicitations. In these cases, a statement **must** follow the Technical Content section in the proposal indicating:

(a) the name and address of any agency to which a proposal was submitted or from which an SBIR award was received;

(b) the date of proposal submission or date of award;

(c) the title, number, and date of the SBIR program solicitation under which a proposal was submitted or award received;

(d) the title of the research project; and

(e) the name and title of the principal investigator for each proposal submitted or award received.

If no equivalent proposal is under consideration or equivalent award received, a statement to that effect **must** be included in this section.

3.5 Prior SBIR Phase 2 Awards

If a small business concern has received more than 15 Phase 2 awards from **all** Federal agencies in the prior 5 fiscal years, it must submit on a separate page, the names of awarding agencies, dates of awards, funding agreements numbers, amounts, topics or subtopic titles, follow-on agreements amounts, sources and dates of commitments, and current commercialization status for each Phase 2. This required information shall not be part of the page count limitation.

3.6 Proposed Budget

Complete the "SBIR Proposal Summary Budget" (Section 9) for the Phase 1 effort, and include it as the last page of the proposal. Some items of this form may not apply. Enough information should be provided to allow DOC to understand how the offeror plans to use the requested funds if the contract or grant is awarded. A complete cost breakdown should be provided giving labor rates, proposed number of hours, overhead, G&A, and profit. A reasonable profit will be allowed. When proposing travel, identify the number of trips, people involved, labor categories, destination of travel, duration of trip, commercial air fare or mileage rate, per diem expenses, and purpose of travel. Budgets for travel funds must be justified and related to the needs of the project.

Where equipment is to be purchased, list each individual item with the corresponding cost. The inclusion of equipment will be carefully reviewed relative to need and appropriateness for the research proposed. Equipment is defined as an article of nonexpendable, tangible property having a useful life of more than 1 year and an acquisition cost of $5,000 or more per unit.
Title to equipment will be vested with DOC, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment. Equipment purchased with DOC funds will be inventoried by DOC.

SBA Policy requires that DOC not issue SBIR awards that include provisions for subcontracting any portion of the contract back to the originating agency or any other Federal agency.

For Phase 1, a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm. The total cost for all consultant fees, facility leases, usage fees, and other subcontract or purchase agreements may not exceed one-third of the total contract. For Phase 2, one-half of the research and/or analytical effort must be performed by the proposing firm.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

All Phase 1 and 2 proposals will be evaluated on a competitive basis. Each Phase 1 proposal will be screened by DOC to ensure that it meets the administrative requirements outlined in Section 4.2. Proposals that meet these requirements will be peer reviewed, undergo competition within each laboratory, and may also undergo a third round of competition across the agency.

4.2 Phase 1 Screening Criteria

To avoid misunderstanding, small businesses are cautioned that Phase 1 proposals not satisfying all the screening criteria shall be returned without peer review and eliminated from consideration for a contract. Proposals may not be resubmitted (with or without revision) under this solicitation. All copies of proposals that fail the screening process will be returned. The screening criteria are:

(a) The proposing firm must qualify as a small business (Section 2.1). If it is a subsidiary of another firm, this limit applies to all employees under control of the parent organization.

(b) The Phase 1 proposal must meet **all** of the requirements stated in Section 3.

(c) The Phase 1 proposal must be limited to one subtopic and clearly address research for that subtopic.

(d) **Phase 1 proposal budgets must not exceed $75,000 (except subtopics with the suffix "SG", which are limited to $50,000),** including subcontract, indirect cost, and fee.

(e) **The project duration for the Phase 1 research must not exceed 6 months.**

(f) A minimum of two-thirds of expenditures under each Phase 1 project must be carried out by the proposing firm.

(g) The proposal must contain information sufficient to be peer reviewed as research.

4.3 Phase 1 Evaluation and Selection Criteria

Phase 1 proposals will be rated by NOAA and NIST scientists or engineers with equal consideration given to the following criteria, except for item (a), which will receive twice the value of any of the other items:

(a) The scientific and technical merit of the Phase 1 research plan and its relevance to the objectives, with special emphasis on its innovativeness and originality.

(b) Importance of the problem or opportunity and anticipated benefits of the proposed research to DOC, and the commercial potential, if successful.

(c) How well the research objectives, if achieved, establish the feasibility of the proposed concept and justify a Phase 2 effort.

(d) Qualifications of the principal investigator(s), other key staff, and consultants, and the probable adequacy of available or obtainable instrumentation and facilities.

Technical reviewers will base their ratings on information contained in the proposal. It cannot be assumed that reviewers are acquainted with any experiments referred to, key individuals, or the firm.

Final award decisions will be made by DOC based upon ratings assigned by reviewers and consideration of additional factors, including possible duplication of other research, the importance of the proposed research as it relates to DOC needs, and the availability of funding. DOC may elect to fund several or none of the proposals received on a given subtopic. Upon selection of a proposal for a Phase 1 award, DOC reserves the right to negotiate the amount of the award.

4.4 Phase 2 Evaluation and Selection Criteria

The Phase 2 proposal will undergo DOC and/or external peer review for the purpose of determining overall technical or scientific merit. Each of the following evaluation criteria will receive approximately equal weight, except for item (a), which will receive twice the value of any of the other items:

(a) The scientific and technical merit with emphasis on innovation and originality.

(b) Degree to which the Phase 1 objectives were met.

(c) The commercial potential of the proposal as evidenced by: a) a record of commercialization, b) the existence of Phase 2 funding commitments from non-SBIR sources, c) existence of Phase 3 follow-on commitments, and d) the

presence of other indications of commercial potential of the research.

(d) The adequacy of the Phase 2 objectives to meet the problem or opportunity.

(e) The qualifications of the principal investigator and other key personnel to carry out the proposed work.

Upon selection of a proposal for Phase 2 award, DOC reserves the right to negotiate the amount of the award.

4.5 Release of Proposal Review Information

After final award decisions have been announced, the technical evaluations of a proposal will be provided to the proposer only upon written request and for a period not to exceed 90 days. The identity of the reviewers will not be disclosed.

5.0 CONSIDERATIONS

5.1 Awards

Contingent upon availability of funds, DOC anticipates making about **40** Phase 1 firm-fixed-price contracts of no more than **$75,000** each (except for subtopics with the suffix "SG", which are limited to $50,000). Of these, approximately **10** will be made by the National Oceanic and Atmospheric Administration (NOAA) and approximately **30** by the National Institute of Standards and Technology (NIST). Performance period shall be no more than 6 months beginning on the contract start date.

Historically, DOC has funded five to ten percent of the Phase 1 proposals submitted.

Phase 2 awards shall be for no more than **$300,000** (except subtopics with an "SG" suffix, which are limited to $200,000). The period of performance in Phase 2 will depend upon the scope of the research, but should not exceed 24 months.

It is anticipated that **approximately one-third of the Phase 1 awardees will receive Phase 2 awards,** depending upon the availability of funds. To provide for an in-depth review of the Phase 1 final report and the Phase 2 proposal and commercialization plan, Phase 2 awards will be made approximately 7 months after the completion of Phase 1.

For planning purposes, proposers should understand that Phase 1 awards are made in July, Phase 2 proposals are due the following February, and Phase 2 awards are made during August and September.

This solicitation does not obligate DOC to make any awards under either Phase 1 or Phase 2. Furthermore, DOC is not responsible for any monies expended by the proposer before award of any contract or grant resulting from this solicitation.

5.2 Reports

Seven copies of a final report on the Phase 1 project shall be submitted to DOC within 30 calendar days after completion of the Phase 1 research. The final report shall include a single-page project summary as the first page, identifying the purpose of the research, and giving a brief description of the research carried out, the research findings or results, and the commercial applications of the research in a final paragraph. The remainder of the report should indicate in detail the research objectives, research work carried out, results obtained, and estimates of technical feasibility.

All final reports must carry an acknowledgment on the cover page such as: "This material is based upon work supported by the Department of Commerce under the contract number _____. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the Department of Commerce."

5.3 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the Government and the successful Phase 1 or Phase 2 contractor.

5.4 Proprietary Information, Inventions, and Patents

5.4.1 Limited Rights Information and Data

Information contained in unsuccessful proposals will remain the property of the proposer. Any proposal which is funded will not be made available to the public, except for the "Project Summary" page.

The inclusion of proprietary information is discouraged unless it is necessary for the proper evaluation of the proposal.

Proprietary information submitted to DOC will be treated in confidence, to the extent permitted by law, if it is confined to a separate page or pages and marked with a legend reading:

> "Following is proprietary information which (name of proposing firm) requests not be released to persons outside the Government, except for purposes of evaluation."

Any other legend will be unacceptable to the Department of Commerce and may constitute grounds for return of the proposal without further consideration. Without assuming any liability for inadvertent disclosure, DOC will limit dissemination of such information to its employees and, where necessary for evaluation, to outside reviewers on a confidential basis.

Since technical reports may eventually be made available to the public, such reports shall not contain any language limiting their use other than for SBIR data as described below.

5.4.2 Copyrights

The contractor may normally establish claim to copyright any written material first produced in the performance of an SBIR contract. If a claim to copyright is made, the contractor shall affix the applicable copyright notice of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including contract number) to the material when delivered to the Government, as well as when the written material or data are published or deposited for registration as a published work in the U.S. Copyright Office. For other than computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.

For computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license for all such computer software to reproduce, prepare derivative works, and perform publicly and display publicly, by or on behalf of the Government.

5.4.3 Data Rights

Except for copyrighted data, the Government shall normally have unlimited rights in:

(a) data specifically identified in the SBIR contract to be delivered without restriction;

(b) form, fit, and function data delivered under the contract;

(c) data delivered under the contract that constitute manuals or instructions and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under the contract; and

(d) all other data delivered under the contract unless identified as SBIR data.

According to Federal Acquisition Regulation 52.227-20, Rights and Data - SBIR Program (March 1994), the contractor is authorized to affix the following "SBIR Rights Notice" to SBIR data delivered under the contract:

SBIR RIGHTS NOTICE

These SBIR data are furnished with SBIR rights under Contract No. _____ (and subcontract _____, if appropriate). For a period of 4 years after acceptance of all items to be delivered under this contract, the Government agrees to use these data for Government purposes only, and they shall not be disclosed

outside the Government (including disclosure for procurement purposes) during such period without permission of the contractor, except that, subject to the forgoing use and use by support contractors. After the aforesaid 4-year period, the Government has a royalty-free license to use, and to authorize others to use on its behalf, these data for Government purposes, but is relieved of all disclosure prohibitions and assumes no liability for unauthorized use of these data by third parties. This Notice shall be affixed to any reproductions of these data, in whole or in part.

(END OF NOTICE)

The Government's sole obligation with respect to any properly identified SBIR data shall be as set forth in the paragraph above.

5.4.4 Patents

Small business firms normally may retain the worldwide patent rights to any invention made with DOC support. DOC receives a royalty-free license for Federal Government use, reserves the right to require the patent holder to license others in certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must manufacture it domestically. To the extent authorized by P.L. 102-564, DOC will not make public any information disclosing a DOC-supported invention for a 4-year period to allow the contractor a reasonable time to pursue a patent.

5.5 Awardee Commitments

Upon the award of a contract, the contractor will be required to make certain legal commitments. The outline that follows illustrates the types of provisions that will be included in the Phase 1 contract.

(a) Standards of Work. Work performed under the contract must conform to high professional standards.

(b) Inspection of Work. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

(c) Examination of Records. The Comptroller General (or a duly authorized representative) shall have the right to examine pertinent records of the contractor involving transactions related to this contract.

(d) Default. The Government may terminate the agreement if the contractor fails to perform the work contracted.

(e) Termination for Convenience. The contract may be terminated at any time by the Government if it deems termination to be in the best interest, in which case the

contractor will be compensated for work performed and for reasonable termination costs.

(f) Disputes. Any dispute concerning the contract, which cannot be resolved by agreement, shall be decided by the Contracting Officer with right to appeal.

(g) Contract Work Hours. The contractor cannot require an employee to work more than 8 hours a day or 40 hours a week, unless the employee is compensated accordingly (i.e., receives overtime pay).

(h) Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

(v) Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran of the Vietnam era.

(j) Affirmative Action for the Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

(k) Officials Not to Benefit. No member of or delegate to Congress shall benefit from any SBIR contract.

(l) Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation, except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

(m) Gratuities. The contract may be terminated by the Government if any gratuity has been offered to any representative of the Government to secure the contract.

(n) Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

(o) American-Made Equipment and Products. When purchasing either equipment or a product with funds provided through the contract, purchase only American-made equipment and products, to the extent possible in keeping with the overall research needs of the project.

5.6 Additional Information

(a) Projects--The responsibility for the performance of the principal investigator, and other employees or consultants who carry out the proposed work, lies with the management of the organization receiving an award.

(b) Organizational Information--Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel, and financial information to assure responsibility of the proposer.

(c) **Duplicate Awards--If an award is made under this solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by any agency of the Federal Government. Severe penalties may result from such actions.**

This program solicitation is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

6.0 SUBMISSION OF PROPOSALS

6.1 Deadline for Proposals

Deadline for Phase 1 proposal receipt (7 copies) at the Department of Commerce Contract Administration Branch is noon on January 13, 1999.

DOC assumes no responsibility for evaluating proposals received after the stated deadline or that do not adhere to the other requirements of this solicitation (see checklist at back of booklet). Such proposals may be returned to the proposer without review.

Federal Acquisition Regulation (FAR 52 215-1) regarding late proposals shall apply.

Letters of instruction will be sent to those eligible to submit Phase 2 proposals. The Phase 2 proposals are due at about the same time as Phase 1 final reports - 7 months after commencement of the Phase 1 contract.

Proposers are cautioned to be careful of unforeseen delays which can cause late arrival of proposals at DOC, resulting in them not being included in the evaluation procedures. No information on the status of proposals under scientific/technical evaluation will be available until formal notification is made.

6.2 Proposal Submission

Proposals (7 copies) should only be addressed to:

ATTN: SBIR Proposals
U.S. Department of Commerce, NOAA
Contract Administration Branch, Code OFA513
1305 East-West Highway, SSMC4, Station 7604
Silver Spring, Maryland 20910
Telephone: (301) 713-0829

For local delivery, the Contract Administration Branch is located near the intersection of East-West Highway and Colesville Road, and close to the Silver Spring Metro stop.

Acknowledgment of receipt of a proposal by DOC will be made by **mail only**. Electronic submissions will not be accepted. All correspondence relating to proposals must cite the specific **proposal number** identified on the acknowledgment letter and be sent to the above address.

(a) **Packaging--Secure packaging is mandatory. The DOC cannot process proposals damaged in transit. All 7 copies of the proposal must be sent in the same package. Do not send separate "information copies," or several packages containing parts of a single proposal, or two packages of 7 copies of the same proposal. The top copy must be signed as an original by the principal investigator and the corporate official. Other copies may be photocopies.**

(b) Bindings--**Do not use special bindings or covers.** Staple the pages in the upper left hand corner of each proposal. Separation or loss of proposal pages cannot be the responsibility of DOC.

6.3 Warning

While it is permissible, with proper notification to DOC, to submit identical or essentially equivalent proposals for consideration under numerous Federal program solicitations, it is unlawful to enter into contracts requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 General Information

The following organizations may be sources for providing technology search and/or document services and may be contacted directly:

NOAA Library
1315 East-West Highway
Second Floor, SSMC3
Silver Spring, MD 20910
(301) 713-2600

NIST Library
Admin. Bldg., Room E106
Gaithersburg, MD 20899
(301) 975-3052

National Technology Transfer Center (NTTC)
316 Washington Avenue
Wheeling, WV 26003
(304) 243-2520

Mid-Atlantic Technology Applications Center
3400 Forbes Avenue
5th Floor, Eureka Building
Pittsburg, PA 15260
(412) 648-7000

Southern Technology Applications Center
One Progress Blvd.
Box 24
Alachua, FL 32615
(904) 462-3913

UK Technology Applications Center
University of Kentucky
109 Kinkead Hall
Lexington, KY 40506-0057
(606) 257-6322

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

NERAC, Inc.
One Technology Drive
Tolland, CT 06084
(203) 872-7000

Small Business Innovation Center
Advanced Technology Center of Southeastern Pennsylvania
3624 Market Street
Philadelphia, PA 19104
(215) 382-0380

NASA Far West Regional Technology Transfer Center
University of Southern California
3716 South Hope Street, #200
Los Angeles, CA 90007
(213) 743-2353

7.2 Oceanography and Marine Science

Scientific information in the areas of oceanography and marine science may be obtained from the following organizations:

University of Alaska
P.O. Box 755040
Fairbanks, AK 99775
907/474-7086

University of California-San Diego
9500 Gilman Drive
LaJolla, CA 92093
619/534-4440

Hancock Institute for Marine Studies
University Park
Los Angeles, CA 90089
213/740-1961

University of Connecticut
1084 Shennecossett Road
Groton, CT 06340
203/445-3457

University of Delaware
Robinson Hall, Rm 111
Newark, DE 19716
302/831-2841

University of Florida
Building 803
Gainesville, FL 32611
904/392-5870

University of Georgia
Ecology Building
Athens, GA 30602
706/542-6009

University of Hawaii
1000 Pope Road, Rm. 223
Honolulu, HI 96822
808/956-7031

University of Illinois
65 Mumford Hall
1301 W. Gregory Drive
Urbana, IL 61801
217/333-9448

Purdue University
1159 Forestry Building
W. Lafayette, IN 47907
317/494-3573

Louisiana State University
128 Wetland Resources
Baton Rouge, LA 70803
504/388-6710

University of Maine
14 Coburn Hall
Orono, ME 04469- 0114
207/581-1436

University of Maryland
0112 Skinner Hall
College Park, MD 20742
301/405-6371

Massachusetts Institute of Technology
Bldg. E38, Room 330
77 Massachusetts Avenue
Cambridge, MA 02139
617/253-7131

Woods Hole Oceanographic Institution
CRL 209
Woods Hole, MA 02543
508/457-2000 ext. 2665

University of Michigan
4107 I.S.T. Building
2200 Bonisteel Blvd.
Ann Arbor, MI 48109
313/763-1437

University of Minnesota
2305 East 5th Street
Duluth, MN 55812
218/726-8106

MS-AL Sea Grant Consortium
P.O. Box 7000
703 East Beach Drive
Ocean Springs, MS 39564
601/875-9341

University of New Hampshire
Ocean Process Analysis Lab.
142 Morse Hall
Durham, NH 03824
603/862-3505

NJ Marine Sciences Consortium
Building No. 22
Ft. Hancock, NJ 07732
908/872-1300

State University of New York
115 Nassau Hall
Stony Brook, NY 11794
516/632-6905

North Carolina State University
Box 8605
Raleigh, NC 27695
919/515-1454

Ohio State University
1541 Research center
1314 Kinnear Road
Columbus, OH 43212
614/292-8949

Oregon State University
Administrative Services
Corvallis, OR 97331
503/737-3396

University of Puerto Rico
Department of Marine Science
P.O. Box 5000
Mayaguez, PR 00681
809/832-3585

University of Rhode Island
Marine Resources Bldg.
Narragansett Bay Campus
Narragansett, RI 02882
401/792-6800

South Carolina Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
803/727-2078

Texas A&M University
1716 Briarcrest Drive
Suite 702
Bryan, TX 77802
409/845-3854

Virginia Graduate Marine Science Consortium
Madison House 170 Rugby Road
Charlottesville, VA 22903
804/924-5965

University of Washington
HG-30
3716 Brooklyn Ave, N.E.
Seattle, WA 98105- 6716
206/543-6600

University of Wisconsin-Madison
1800 University Avenue
Madison, WI 53705
608/262-0905

8.0 TECHNICAL TOPICS

The subtopics in sections 8.1 through 8.5 are from the National Oceanic and Atmospheric Administration (NOAA). Approximately 10 awards will be made on these subtopics.

8.1 NOAA TOPIC: ATMOSPHERIC SCIENCES

8.1.1A Subtopic: Low-cost Rugged Pressure Sensors for Large-scale Deployment in Tornado Prone Areas

Measurements of the pressures associated with tornadoes could permit estimates of the wind speeds in tornado cores. For this research topic, a static pressure probe is needed that has equal or greater measurement characteristics as the probe described by Nishiyama and Bedard (1991). The probe will permit accurate measurements of pressure in the presence of high winds. A small, rugged pressure sensor needs to be integrated with this probe to measure tornadic pressure fields. Also, a low current circuit is required that will save a time series for a signal that meets tornado criteria (a drop in pressure of greater than 2 millibars in less than 5 minutes). The device should permit downloading to a computer. Other uses, in addition to large scale deployments in tornado prone areas, include rapid deployments by chase teams in sufficient quantities to increase the probability of a direct hit.

Reference:

Nishiyama, R. and A. Bedard. Review of Scientific Instruments. Volume 62, pp2193-2204, 1991.

8.1.2A Subtopic: Low-cost Transportable HF Skywave Radar

The Environmental Technology Laboratory is interested in a low-cost, transportable HF skywave (ionospheric) radar for long-range monitoring of ocean-surface winds, waves, and currents. The range and spatial resolution of the radar would be comparable to that achieved by the Navy's Relocatable Over-the-Horizon Radar (ROTHR) system. The proposed system is expected to have reduced requirements for transmitter power, ruggedness, target tracking, and other military specifications that would reduce the cost to one-tenth that of the ROTHR. The radar should operate between 10 and 28 Mhz and would employ linear frequency modulation. Innovative antenna/signal-processing technology should reduce the size and complexity of the receiving and transmitting arrays. Commercially available components should be extensively employed to keep hardware costs to a minimum. Software and other concepts already developed for military OTH radar systems should also be adapted to the maximum extent possible. The radar should incorporate a rudimentary sweep-frequency backscatter sounder and a spectrum monitor for frequency management. Proposals must be innovative and achieve simplicity in ease of operation and maintenance, and economy, consistent with the requirements for usable sea-echo signals.

8.1.3A Subtopic: Real-Time Video Computerized/Automated Analysis of Atmospheric Conditions

With the improvements in real time video and Charge Couple Display (CCD) technology systems, the potential for increased automation of atmospheric monitoring/analysis is feasible. There are many techniques and improvements that have occurred in the last several years in the digitization, segmentation, optimization, and pattern recognition areas that can be applied to the processing of video data signals. These approaches encompass utilizing artificial intelligence, knowledge based expert systems, advanced pattern recognition techniques, and neural network techniques for video signals. Through modern computer processing capabilities, a real time weather monitoring system, that is integrated into automated systems, could effectively detect, measure, collect, and generate atmospheric data. This research topic combines the usage of advanced video camera and CCD sensor technology with developing new processing techniques. The end result would be the merging of advanced hardware video systems and sensors with computerized software and video processing techniques. These advanced video devices and processing software could eventually be integrated into future automated weather observing and analysis systems.

8.1.4A Subtopic: Microwave Remote Sensing of the Ocean Surface Wind Vector Using Passive Polarimetry

The ocean surface wind vector is an important environmental parameter for research and operational marine forecasting. Investigators over the last several years have shown that it is possible to measure the ocean surface wind vector using a polarimetric microwave radiometer system. A compact system is sought to deploy on the NOAA WP-3D aircraft during hurricane reconnaissance flights and other flights of opportunity. Since other instrumentation typically occupies all the downward looking ports along the aircraft fuselage, integration into a modified WP-3D fuel pod is necessary. Modification of the pod would include any necessary radome and mounting structures for the radiometer system. The polarimetric microwave radiometer should be capable of scanning at least ±70 degrees off of the aircraft heading at a fixed incidence angle between 45 to 65 degrees from nadir. The radiometer system will have to account for atmospheric effects such as water vapor and precipitation for wind retrievals in the desired range of 0-70 meters/second. The instrument sensitivity and calibration must be capable of wind speed and direction retrieval accuracy of ±2 meters/second and ±20 degrees. A spatial resolution on the ocean surface of approximately 1.5 km at an altitude of 20,000 feet is desired at an incidence angle of 55 degrees. The ability to report the winds in real time should also be considered in the system design to allow the relaying of information to hurricane forecasters during any hurricane reconnaissance flights. A quantitative measure of rain rate is also desired, and would be required for any real time system. The entire system should be as compact and self-contained as possible to minimize potential interference with other equipment. Existing wiring in the aircraft wing should be utilized for any necessary interfacing between the pod and the main cabin.

8.2 NOAA TOPIC: OCEAN OBSERVATION SYSTEMS

8.2.1A Subtopic: Operational Ocean Instrumentation, Measurement, and Data/Information Dissemination Systems

Development of operational ocean instrumentation, measurement, and data/information dissemination systems is sought to support a wide range of NOAA's National Ocean Service (NOS) operational activities, such as the Physical Oceanographic Real-Time System (PORTS) program, the National Water Level Observation Network (NWLON), coastal and estuarine forecast systems, and environmental monitoring associated with sustaining healthy coasts. Development generally includes sensing, data acquisition, and information dissemination. NOAA emphasizes systems that can be operated in an unattended mode. Where personnel are needed, use of only minimal skill levels is advantageous. These systems should provide near real-time data acquisition and dissemination. High reliability, known accuracy, and cost effectiveness are important design considerations. The parameters of interest are comprehensive, including (1) physical, chemical, and biological properties of the coastal ocean environment, (2) pollutants, and (3) overlying atmospheric parameters. These systems provide marine environmental information in support of safe navigation, safe transportation of hazardous materials, economic benefits to marine commerce, and management of marine resources.

Of particular interest this year are proposals relative to the following:

a). Bridge Clearance (air gap) Sensor - A sensor to directly measure the under bridge to water surface distance in real time is sought. The sensor needs to cover the range of 5 to 50 meters with an uncertainty of less than 5 centimeters. It has to work in all kinds of weather, water, and surface conditions including, but not limited to, sunlight, temperature, fog, rain, high winds, ice, oil slicks, fresh or salty, clear or muddy, and waves. Power consumption is a concern because many sites have no or difficult access to line power. The data output would be for a sampling period of one to six minutes, would eliminate any erroneous signals from passing boats and ships, and would give statistical data such as mean, standard deviation, maximum and minimum values, changes from last sampling period, estimate of uncertainty due to waves, etc.

b). Real-Time Water Density Profile Technology - The tonnage and draft of present day commercial ships has drastically reduced the safety margin of keel clearance. Many factors that could affect the keel clearance have to be re-examined to ensure navigation safety. Water density is a factor not readily measured at present, but it has direct effect on vessel draft. In estuarine waters, such as bays and harbors, water density often changes with the tidal phase and fresh water inflow. A one to three percent change in density is possible. A remote sensing method (such as ocean bottom mounted looking upward or on a surface buoy looking downward) that could provide real-time density information over at least the upper 90% of the vertical water column at the measurement location is sought. The accuracy of density measurement shall be 0.5% of full scale or better. Water density is a candidate for integration with NOS PORTS installations.

c.) Long-Term and Real-Time Water Quality Monitoring System - Water quality in estuarine waters, such as bays and harbors, is important to coastal ecological health, recreation, and commerce. A reliable, in-situ system that can measure dissolved oxygen, and /or chlorophyll, and/or nitrogen is sought. Features such as an unattended long service interval (3-month or longer) and real-time reporting (interval of 1-hour or less) are essential. Technical problems associated with marine fouling, mineral precipitation, and corrosion should be considered. The technology is a candidate for integration with NOS PORTS installations.

8.2.2A Subtopic: Automated Ocean/Atmosphere Observations from Volunteer Observing Ships

A critical element of the global ocean observing system that supports NOAA's climate and weather forecast mission is the Volunteer Observing Ship (VOS) fleet. Accurate, timely weather and sea condition reports from commercial ships transiting the vast ocean regions are essential for initializing climate and weather forecasts. Also the long term data sets compiled from these ship observations are of fundamental importance to climate research. A data continuity/reliability problem exists due to the variety of instruments and techniques used by various ships to make the at sea observations. Over the past ten years, highly accurate meteorological and ocean temperature sensors have been developed for use aboard research vessels, but these research instruments have not been integrated into an automated shipboard system, and they remain too expensive to be practically deployed operationally, on a large scale, aboard volunteer ships. Proposals are sought to develop a research quality, low cost, integrated VOS observing system that will automatically sense ocean and atmospheric conditions, and automatically report near real time via NOAA SEAS (Shipboard Environmental (data) Acquisition System). The VOS observing system must have the capability to measure sea surface temperature, true wind speed and direction, barometric pressure, precipitation, air temperature and relative humidity, and provide for optional measurement of other environmental parameters of interest to climate research such as radiation, salinity, and carbon. An interface to accept input from available measurement instruments and report/display upper ocean thermal profiles is required. The system must be designed for ease of installation, maintenance, and routine sensor calibration. A primary objective is to make the VOS observing system as useful to ship operators as it is to scientists and forecasters. The system should provide a shipboard real time graphical display of local conditions as measured by the automated sensors, and be capable of semi-automatically producing the ship's weather log by combining the automated observations with manual entry of communications with marine forecast services for providing shipboard display of weather maps, ship routing, and/or other environmental products of value to ship operations.

8.2.3A Subtopic: Polarimetric Infrared Imaging

NOAA's Environmental Technology Laboratory is studying the potential of polarimetric thermal-infrared imaging for environmental remote sensing, especially of the ocean surface. This solicitation is for development or demonstration of systems for measuring the degree of linear polarization of thermal emission in either the 3-5 μm or 8-12 μm wavelength bands. Multi-or hyper-spectral capability is also of great interest. All systems should be operable in

demanding field environments and from ships and airplanes. Desirable features include small size and weight, capability of maintaining a radiometric calibration to the order of 1%, and rugged design. Operation without cryogens is desirable, but not necessary.

8.2.4A Subtopic: High-Speed Tethered Shipboard Upper-Ocean Profiling System

Profiles of upper-ocean temperature and salinity measured by commercial vessels provide NOAA with critical information for ocean models, weather forecasting, fisheries and climate studies in remote and widespread regions. These measurements are presently collected using expendable profiling devices. Expendable conductivity (salinity)- temperature- depth devices are relatively expensive and generally less accurate then their non-expendable counterparts. Additionally, some commercial ships refuse to deploy expendable plastic devices. Proposals for the development of a tethered, non-expendable conductivity-temperature-depth profiling systems for underway profiling from commercial ships is requested. Developers should consider the following: Profiler should achieve conductivity/temperature/depth accuracies at least as good as commercially available expendable devices; profiles should extend to 750 meters in depth; profiler should function at speeds in excess of 11 meters/sec; data should be downloaded, stored, and available for transmission immediately following a profile. Other positive design factors include: small size and portability; high measurement accuracy; high degree of autonomous operation; low initial and operational cost; durability; and rapid profiling capability.

8.2.5A Subtopic: High Resolution Hyperspectral System for Rapid Coastal Marine Geophysical Data Acquisition and Processing

NOAA monitoring and prediction programs require a rapid assessment of coastal parameters on high spatial, temporal, and spectral scales. A high technology end-to-end hyperspectral scanning system which could be flown from aircraft can greatly help in addressing these needs. Using hyperspectral data, one can infer water quality parameters such as phytoplanton pigments, suspended sediments, planktonic blooms, organic loading as well as macroalagae, submerged aquatic vegetation, and coral reef health. Unlike satellite based systems, deployment from low altitude aircraft would allow for assessment of coastal waters in finer detail, and covering smaller areas, as well as have the added benefit of avoiding cloud cover. This includes simultaneously registering the spectral components and the spatial locations. Onboard data processing and display of the geophysical parameters is also a key component. Due to some very large data volumes collected and processed at once, or stored for later processing, some applications will require sophisticated data processing innovations. In essence, a mobile, compact, low cost system is required that could be deployed by large aircraft. It is important to save measurement time, installation costs, and mechanics while gaining inherent advantages of the measurement principles. The system would need to provide flexible band definitions covering a swath width of 60% of the aircraft altitude or wider to accommodate rapid spatial reconnaissance. A mobile, compact pushbroom imaging spectometer system is desired that can be mounted on aircraft having speeds between 100-150 knots using existing photogrammetric openings in the fuselage. Power requirements of 150W or less should be pursued. Spatial resolution of 600 pixels per swath or better with GPS navigation better than one part per thousand. Data acquisition should be 12 bits at a rate of $\geq$1 Mb/s. The spectral range should be programmable from ~360 to 1200

nm, with user defined variable spectral bandwidths with a 2 nm minimum and a maximum collecting capability of 288 bands or more. The system should be provided with an integrated Inertial Measurement System on a stabilized platform and have PC based instrument collection/processing software (radiometric calibration/correction, geocorrections, and mosaic). The instrument must be spectrally stable and able to withstand a wide range of external thermal and acceleration conditions.

8.2.6A Subtopic: Hydrographic Data Acquisition and Data Processing

NOAA's National Ocean Service is seeking to improve the efficiency and effectiveness of its hydrographic operations. This request is for the development of software and algorithm solutions to problems of data acquisition and data processing. This does not, however, preclude solutions that are primarily hardware in nature. Of particular interest are: a) the blending of bathymetric data and acoustic imagery; b) improved data editing techniques which utilize both the acoustic backscatter strength and slant range time of flight on the several beams of a multibeam bathymetric sonar; c) efficient 3-D visualization of large fields of spatial data; and d) online tools for assessing/assigning quality parameters to bathymetric data as a function of nadir angle and variability of the local bathymetry.

8.2.7A Subtopic: Ship Motion Measurement System Utilizing a GPS/IMU System

Position and motion information are often required for many of the research instruments (such as radars, echo sounders, and high resolution tower instrumentation) installed on NOAA ships and buoys. Navigation and attitude data can be measured many ways ranging from gyrocompasses and Inertial Measurement Units (IMUs) to multi-antenna Global Positioning System (GPS) attitude measurement systems. Combination GPS/IMU systems, but are often expensive. In recent years, the costs of both GPS sensors and IMU's have been dropping. The Environmental Technology Lab seeks an inexpensive (~$15,000) combination GPS/IMU system capable of high accuracy, full 6-degree-of-freedom (6-DOF) (±0.1 m/s translational, ±0.1 rotational) information, as well as accurate heading information (±1). The data will be used in real time and must have a latency of less than 50 ms. The unit should be composed of a GPS sensor assembly, a 6-DOF sensor assembly and a processing unit. It should utilize predictive navigation algorithms (Kalman filtering), such that periodic dropouts of GPS will only marginally impact on the data. It should also be self-calibrating.

8.3 NOAA TOPIC: LIVING MARINE RESOURCES

8.3.1A Subtopic: Live Aquatic Transportation

The objective will be to develop and demonstrate new or improved methods/technologies for the packaging, handling or survivability of live aquatic products for shipment to the global market. The intent of this research is to develop new handling and care techniques involving: respiratory rates, ability to handle stress, excretory functions and temperature tolerances. Examples include: longer lasting coolants for gel packs, reusable container development, modified atmospheric packaging, enhanced package atmospheric monitoring sensors, reusable insulating materials, and

new container designs. Because live aquatics can only be profitable if the live aquatic product arrives in pristine condition, concepts and technological development should clearly demonstrate physiological evidence that the proposal is price competitive with existing technologies presently in use for live shipment.

Reference:

Marketing and Shipping Live Aquatic Products, NRAS-107. Proceedings from Marketing and Shipping Live Aquatic Products. October 13-15, 1996. Seattle, Washington. Topics included 49 papers in the fields of: Animal Welfare, Environmental Issues, Shellfish, Finfish, Ornamentals, Holding and Transport, Marketing and Regulatory issues. 288 pages.

8.4 NOAA TOPIC: OCEAN SCIENCE

8.4.1SG Subtopic: Aquaculture: Developing and Improving Marine Species Culture

Proposals are requested for research which offers to make significant, industry-wide improvements in marine finfish, shellfish, and marine ornamental fish culture systems for both small scale and large scale applications. Priority will be given to research which finds innovative approaches that will solve major industry bottlenecks in an economically and environmentally compatible manner. Research aimed at new marine species for culture and research to adapt techniques being used successfully in other countries are appropriate.

8.4.2SG Subtopic: Aquaculture: Water Reuse and Effluent Treatment Systems

Proposals are requested for developing integrated aquaculture systems with minimum impact on the environment. These include development of innovative water reuse systems for ponds and raceways and other novel systems for treating effluent. Special priority will be given to prototype, modular water reuse systems suitable for producing a variety of species anywhere in the United States.

8.4.3SG Subtopic: Aquaculture of Marine Organisms for Marine Natural Products

Research in the past two decades has found that there are many marine organisms which produce novel natural products of use in treating human diseases. To utilize these products commercially and in clinical trial, however, they need either to be chemically synthesized, produced using biotechnology, or produced through aquaculture of the organism. Research is needed to find economically cost-effective and biologically viable ways to culture marine organisms specifically for their production of novel natural products.

8.4.4SG Subtopic: Open-Ocean Aquaculture Systems

Both engineering and biological technology needs to be explored for the development of open-ocean or offshore culture systems. Large scale, offshore, submersible and floating systems need to be developed for Atlantic, Gulf of Mexico and Pacific conditions. Automation of feeding and

harvesting functions as well as telemetry and remote control systems will be considered in this competition. The biological technology would include hatchery, nursery and transport systems for candidate species for open ocean-aquaculture. Field tests of candidate species are encouraged.

8.4.5SG Subtopic: Sensor Technologies for Measuring & Detecting Microbiota in the Water

Proposals are requested for probes and/or automated sensor technology, for the detection and quantification of specific microbial and environmental water problems, most notably characterization of species-specific identification and detection of human, fish, and shellfish pathogens.

8.4.6SG Subtopic: Bioremediation/Decontamination Technology for Contaminated Sediments

NOAA is seeking proposals to develop bio-remediation technologies as they pertain to treating and mitigating contaminated sediments in coastal and marine aquatic environments.

8.4.7SG Subtopic: Alternative Technologies to Ballast Water Exchange

The problem of nonindigenous species invasions is a growing concern in both Great Lakes and marine coastal waters. Many of these invasions occur through release of ballast water, but other than mid-ocean ballast water exchange, often a time-consuming and occasionally risky process, there is no effective method of eliminating this pathway for introductions. Research is needed to develop efficient and cost-effective alternative technologies to ballast water exchange for the shipping industry, so that mid-ocean exchange of ballast water may be avoided and the risk of introductions reduced.

8.4.8SG Subtopic: Biological Control of *Phragmites australis*

NOAA seeks proposals to develop technologies for the control of *Phragmites australis*. *Phragmites australis* is an aggressive, fast growing plant species that is replacing native marsh vegetation in many wetlands of the east coast of North America. On both shores of Delaware Bay, for example, *Phragmites australis* has replaced over 50% of the natural marsh vegetation. With few natural enemies to control the spread of *Phragmites*, it spreads at an alarming rate, invading brackish coastal wetlands and distributed areas such as diked marsh and agricultural lands. The direct result is a reduction of species diversity and richness of flora and fauna. *Phragmites* has low food and habitat value. *Phragmites* can raise the surface of marshes and ultimately disrupt the natural tidal cycle. Because of the rapid expansion rate of *Phragmites*, approximately 30 feet a year, it reduces habitat for fish, other aquatic organisms and wildlife and eliminates open space that would otherwise be accessible for hunting, fishing, birding and nature study. Currently the options for control of *Phragmites* are limited to mechanical methods (cutting, mowing or disking), impounding, flooding, physical removal (excavation) or spraying

and burning. The widespread use of these methods is limited by cost, short period of effective control, detrimental effect on the marsh as a whole, or in the case of spraying, public opposition. An alternative to these methods is biological control. Currently research is being conducted on *Rhizedra lutoda*, a recently introduced herbivore of *Phragmites australis*, and a form of *Spartina alterniflora* which may be able to compete with *Phragmites australis*. Both may offer long term biological control strategies. Further development of these or other biological control strategies, towards a commercially viable method, are needed.

8.4.9SG Subtopic: Technology for Sampling Marine Organisms and Their Native Environment at Deep-Sea Hydrothermal Vents

The diversity of marine organisms, primarily microbes, at deep-sea hydrothermal vents is currently getting much attention. Techniques to sample these organisms in a manner which allows for collecting live samples in their native environment is currently not available. We need sample techniques to gather organisms so they can survive uncontaminated in their native environment, and probe technology to sample the native micro environment of the organisms. Culture techniques are also needed which can replicate the natural environment of these organisms, so they can be studied at the surface and in the laboratory. These technologies would greatly enhance our ability to study the organisms from the deep-sea hydrothermal vents, the extremophiles, and their natural processes and products.

8.4.10A Subtopic: Underwater Scaling Device for Generating Graphic Scale Video Overlay

The ability to derive a measurement scale while viewing underwater video has always been a difficult task because of distortion due to refraction, physical structure of the camera lens, and viewing a three dimensional world on a two dimensional screen. Efforts to introduce a scaling device into the video picture have ranged from a graduated stick, to parallel laser beams, to a laser with an acoustic component for determining range. What is needed is an underwater scaling device that utilizes a computer graphics generator to analyze sets of parallel and/or deviating laser beams to determine distance and skew of the plane being viewed, and then project a scalar grid on the video screen. With a defined angle of view from a video camera, the laser dots (lines or circles using different optics) would be identified by clicking on them with a cursor, and the computer would calculate the distance and skew of the viewed plane to determine scale. A scale grid would then be projected or generated onto the video picture. The system provides a "snap-shot" mode that would be very useful for post analysis of the video, but real time scaling of the video picture in the field is highly desirable. Real time application requires the computer to be able to track the lasers in the video and constantly update the scale grid projected on the video screen, instead of having the operator identify the laser projections manually. The system should also be able to project scale grids at desired distances from the video camera for mid-water work where the lasers have no solid object to project upon.

8.5 NOAA TOPICS: CARTOGRAPHY AND PHOTOGRAMMETRY

8.5.1A Subtopic: Cartographic Data and Geographic Information Systems (GIS)

Innovations with commercial potential are sought incorporating new and emerging technologies related to digital cartographic and GIS systems to support National Ocean Service (NOS) requirements. The NOS makes its products, data, and metadata available to agencies, academia and the public through electronic access via computer networks. Needed research critical to the NOS mission includes:

a) Heads-up raster and vector navigation and nautical charting display systems. Such systems could show data in 2 and 3 dimensional displays for mariners. Such practical information could be shown on (semi-)transparent, portable, heads-up displays superimposed in novel ways on the actual environment to help mariners navigate, especially in conditions of limited visibility.

b) A comprehensive method for remote, real time monitoring and display of navigation channel depths to within 1 foot and widths to within 10 feet throughout the entire channel length (1 mile to 100 miles). The method must be comparable in cost to the periodic sonar surveys currently in use. A "survey" by this method should require 24 hours or less, if possible.

c) New methods for generation, update, and transfer of geo-data products and data files from spatial data bases, including raster images, to meet emerging requirements of the Electronic Chart Display and Information System (ECDIS) and similar shipboard electronic navigation systems using raster displays.

d) User-transparent approaches to geo-data and geo-processing interoperability across networks (e.g., the Internet), for: software interoperability: automatically invoked platform independent processing functions, and data interoperability: user-transparent autonomous standard file format conversions.

e) Innovations for easily locating, accessing, searching, transferring, reformatting, and portraying geo-data and GIS graphic products across networks. These could involve knowledge processing via expert systems and/or neural nets, hyper-links (e.g., Netscape-like), geospatial search engines, or improved conventional techniques.

f) New methods for enhancing/compressing raster images of nautical chart features, including text and feature symbology. These can range from conventional image processing and optical character recognition algorithms to the use of expert systems, fuzzy logic, neural nets, and specialized pattern recognition/matching algorithms.

g) Improved methods for error-free raster-to-vector and vector-to-raster conversion/compression for digital raster images, including semi-automated GIS data attribution and metadata generation directly from the vectorized raster data files.

The subtopics in sections 8.6 through 8.22 are from the National Institute of Standards and Technology (NIST). Approximately 30 awards will be made on these subtopics.

8.6 NIST TOPIC: ADAPTIVE LEARNING SYSTEMS

8.6.1T Subtopic: Web Based Instructional Platforms

Recent innovations in information technology have tremendous potential to make learning and instruction more affordable, accessible, and adaptable than ever before. Yet new software and systems are required if this potential is to be realized. Technical challenges abound in: (a) knowledge representation and management – making educational content accessible to diverse users, while facilitating the acquisition, organization, and dissemination of information relevant to learning; (b) interaction facilitation – making objects in an on-line learning environment that are malleable and supportive of diverse, multifaceted collaboration (both synchronous and asynchronous); and (c) learning contextualization – maintaining the orientation and involvement of multiple learners in an on-line instructional setting (e.g., through simulation). The goal is to develop technical solutions that reduce the costs of producing instructional software and systems, make educational systems easier to use, and improve manageability and quality of service levels in distributed systems.

Proposals are solicited that will develop enabling technologies that support flexible, network-based — especially Web-based — learning systems. These systems will include all or some of the following features: intelligent authoring systems to reduce the cost and time to market for educational content; knowledge management technologies to improve the delivery of instructional content, when and where needed, in the most useful form; and large-scale modular components, instructional frameworks and middleware to support highly usable, reliable networked learning environments that include the special transactions needed for training and education. In order to achieve this system, needed innovations include: Modes of Delivery (technical solutions for synchronous and asynchronous collaboration, as well as for providing access and data mobility in a complex system of distributed repositories); Search & Retrieval (infrastructure to support educators, students, and workers with complex information acquisition and management requirements); and Quality of Service (middleware applications to reduce latency and insure the robustness of high-performance applications in the midst of scale-up and extension). Proposals that take advantage of next generation Internet (NGI), align with emerging industry standards in Web-based instruction, and/or address the particular needs of the U.S. workforce are encouraged.

8.7 NIST TOPIC: ADVANCED BUILDING MATERIALS AND SYSTEMS

8.7.1T Subtopic: Direct Electrical Measurement of Cement Hydration

A problem of long-standing interest and importance is to find a method to directly measure the degree of hydration of cement, in a non-destructive manner, and suitable for the field. All of the ultimate properties of concrete depend on the hydration of the cement paste matrix: strength, pore structure, stiffness, etc. These properties determine, to a large degree, the service life of the concrete. Such a technique would be useful for construction, in telling quantitatively when enough curing aids have been used on fresh concrete (plastic covering, curing compounds, water added to the surface ,etc.). It would also be useful in determining service life, as the total curing that a concrete will attain could be assessed to see if it is enough to produce a reasonable service life.

We are interested in obtaining such a device to carry out the measurement described above. To be simple, inexpensive, non-destructive, and portable for field work, such a measurement should be electrical in nature. It must directly measure the degree of hydration of the cement, and not just be a correlation between, say, D.C. conductivity and degree of hydration. Such empirical correlations do not hold up well between different materials. This device should operate by measuring the changes taking place in either the cement or the water, which are both being consumed in the hydration reaction. The device's operation should be validated on NIST standard cements.

8.7.2T Subtopic: Variable Contact Time Impactor

The impact-echo method is a nondestructive testing technique for locating flaws in concrete or for measuring the thickness of concrete members. The test method involves an impact source, a receiving transducer, and a data acquisition/analysis system. The success of the method is based, in part, on having the correct type of impact. The research that led to the development of the impact-echo method used steel spheres dropped onto the concrete surface as the impact source. By using spheres of different diameters, we could vary the contact time of the impact and, therefore, the frequency content of the stress. Subsequent commercial test instruments have relied on spring loaded steel spheres of different sizes to provide the impact. The objective of this subtopic is to demonstrate the feasibility of developing an advanced impact source for use in impact-echo testing. The source shall be capable of producing a stress pulse having the same characteristics as obtained by impact with a steel sphere. The contact time of the impact should be adjustable from roughly 10 to 100 microseconds, and the device shall include a means to indicate the actual contact time of the impact. In addition, the device shall not emit electromagnetic radiation that would affect the receiving transducer. Additional information on the impact-echo method and the required characteristics of the impact force may be found in: Sansalone, M., and Carino, N.J., "Impact-Echo: A Method for Flaw Detection in Concrete Using Transient Stress Waves," NBSIR 86-3452, National Bureau of Standards, Gaithersburg, Maryland, Sept., 1986, 222 pp. Order from NTIS, PB#87-104444/AS.

8.7.3T Subtopic: Automated Knowledge Acquisition for Construction Material Knowledge Representation and Exchange

Efficient representation, access, and exchange of construction materials knowledge will advance the area of materials science research and use of knowledge by the construction industry. Timely, accurate, and high-quality knowledge is needed for improved decision-making. New methods must be developed and implemented that provide more efficient human to computer and computer to computer interfaces. The Building and Fire Research Laboratory is undertaking a program that involves the representation, integration, and dissemination of knowledge about construction materials and systems. The major bottleneck in developing systems is the knowledge acquisition phase.

Proposals are invited for developing software tools and techniques that will support automated ontology and knowledge-base development, specifically in the concrete materials area. An ontology provides a rigorous specification to describe the concepts supporting the terminology used to describe construction materials and systems, while the knowledge-base will use the specified concepts in the ontology for representing higher order knowledge. There is a need to understand the meanings and characterize differences in meanings for terms/concepts used in the construction industry, and to translate these meanings into representations that can work within a well defined knowledge sharing framework. Specific interests to be addressed in this proposal include: (1) taking a machine readable dictionary and creating an ontology using automated tools; (2) taking machine readable documents and creating a knowledge-base using the constructed ontology and automated tools; and (3) taking machine readable documents and creating a machine readable dictionary using automated tools.

8.7.4T Subtopic: An Expansion Work Recovery Device for a CO_2 Cycle

With global warming beginning to replace ozone depletion as the world's most significant environmental problem, a few European countries oppose the long-term use of HFC refrigerants. The concern is the moderate Global Warming Potentials (GWPs) of HFCs. Opponents of HFCs promote "natural refrigerants", including carbon dioxide, that have GWP values hundreds or thousands of times smaller than those of HFCs.

Carbon dioxide was used as a refrigerant in the pre-CFC era (before 1930), but it disappeared from the market by 1950 because of a low Coefficient of Performance (COP). Expansion losses in the CO_2 transcritical cycle are responsible to a significant degree for the low COP. Performance of the CO_2 cycle would improve markedly if the expansion work could be utilized. The purpose of this announcement is to solicit proposals for development of a device that would limit expansion losses in the CO_2 cycle. The final goal of this effort (Phase 2) is a prototype of the device integrated into the CO_2 system effecting a substantial increase of COP. Results of Phase 1 must demonstrate the feasibility of the device for Phase 2 to be awarded.

8.7.5T Subtopic: Measurement of Thermal Conductivity of Insulation at High Temperature

Accurate and reliable thermal conductivity measurements at high temperature are required in order to characterize the thermal transport properties of industrial thermal insulation materials. The apparatus shall be capable of measuring thermal conductivities less than 0.04 W Am^{-1} AK^{-1} up to temperatures 1500 K with an uncertainty less than 5 % and repeatability less than 1 %. The apparatus shall measure specimens up to 37 mm in thickness and different temperature differences across the specimen. For this purpose, NIST solicits proposals for the development of an apparatus to determine accurate and reliable thermal conductivity measurements at high temperatures.

8.7.6T Subtopic: Molecular Dynamics Modeling of Polymer Reactivity

Molecular dynamics (MD) has been demonstrated to be useful tool for the investigation of time dependent properties in synthetic polymers. Recent work conducted in the Building and Fire Research Laboratory has led to extensions of MD to account for the major reaction channels involved in the thermal degradation of polymers. This was accomplished by introducing specific reaction pathways, which are known to be active in the thermal degradation of polymers, and switching functions, which turn-on new bonding interactions when the old bonds approach dissociation, into the force field. There is a clear need to augment this model to account for a greater range of chemical properties and reactivity including the capability to model polymer-monomer and monomer-monomer reactions. NIST welcomes proposals for the further development of our reactive MD code which could be used within the polymer industry to develop new strategies for polymer synthesis and processing.

References:

Nyden, M.R., Coley, T.R. and Mumby, S., "Applications of Molecular Dynamics to the Study of Thermal Degradation in Aromatic Polymers;" I. Polystyrene, *Polym. Eng. Sci.*, in press, Sept. 1997.

Nyden, M.R., Forney, G.P. and Brown, J.E., "Molecular Modeling of Polymer Flammability: Application to the Design of Flame-Resistant Polyethylene," Macromolecules, **25**, 1658 1992.

8.7.7T Subtopic: A Methodology to Measure the Compliance of a Building to Performance Goals and Standards

The new paradigm for the construction of buildings in the United States is to use performance codes and standards to allow innovative ideas in the construction and for the new products to be used. The intent is to allow innovative designs and cheaper and better products to be used, while ensuring that buildings are safer and more habitable. Although the goals and functional

statements of these codes and standards are written in increasing order of specificity, it is still difficult to ascertain whether a building complies with either the older prescriptive codes or the newer performance codes. A methodology is needed which will apply these rules to a description of a building, indicate shortcomings and suggest possible modifications or acceptable alterations. This methodology needs to be implemented in a computer program, which applies the implementation of the fuzzy rules of performance codes and standards to a standard building description. The output should be in the standard screen-viewable format of FireWalk or Fire CAD (Autodesk implementation). It is anticipated that this software will focus on the newer, and better described, performance objectives, but allowing for the older prescriptive standards would enhance the commercial impact of such a program. The implementation should allow alternative calculation methods in considering alternatives. Although it is expected that only 5-10% of buildings will be built or refurbished based on these newer codes and standards, experience in other countries indicate that this represents 20% of the investment in such construction and a 5% savings to the construction industry in general. With the U.S. construction market at $500-700B, this will lead to considerable savings. The market for associated software has been increasing dramatically over the past decade.

Reference:

Bukowski, Jones, Cappuccio and Bukowski, "Building Visualization in a Virtual Environment." 2nd International Conference on Performance Codes for Buildings, Society of Fire Protection Engineers, Maui, 1998.

8.8 NIST TOPIC: ADVANCED DETECTION AND SUPPRESSION OF FIRE

8.8.1T Subtopic: Advanced Detection and Monitoring of Fires

A properly designed fire detection system must be able to identify, in a matter of seconds, a fire event which may occur only once in one hundred years, and the identification must lead to an action which is appropriate to the space being protected. Spaces of interest to the Building and Fire Research Laboratory include residential and commercial structures, industrial facilities, and transportation systems. False alarms, maintenance problems, and incomplete or inaccurate information which leads to an improper suppression response are problems that plague many fire detection and/or suppression systems which are economically competitive. As the scientific basis for the identification of the characteristics of a pending fire become better established, research is required to determine how to apply advances in sensing temperature, heat flux, chemical species, particulate matter, and different portions of the electromagnetic and acoustic spectrum to the detection of a hazardous fire. New methods of signal processing and decision-making based upon the most effective use of available knowledge, and the development of systems which adapt to changes to the environment being protected are of particular interest. Proposals for incremental advances to existing fire detection technologies are not solicited. Refer to related descriptions in annual summaries of BFRL research.

8.8.2T Subtopic: Temperature Measurements During Water Sprinkler Extinguishment of Fires

The development of models for describing the extinguishment of fires by water sprinklers is a current research priority of the Building and Fire Research Laboratory (BFRL). An important parameter to be used for validation of such models is the gas temperature field in the region influenced by both the sprinkler and the fire. Such measurements are particularly difficult due to the presence of both heated fire gases and water droplets. Innovative proposals are solicited by BFRL for a temperature sensor which is capable of measuring local gas-phase temperatures (room temperature to 500 K) with a minimum sampling rate of 100 Hz during sprinkler-extinguishment of fires. Important considerations include high spatial resolution, ease of use in fire test, robustness, ability for automated data acquisition, and reasonable cost.

8.8.3T Subtopic: Advanced Temperature Probe for Fire Testing

As the computational methods used to model fire scenarios become more sophisticated, there is a pressing need to reduce the uncertainty of and to improve the temporal resolution of temperature measurements used for validation. Thermocouple-based gas temperature measurements in fires are plagued by uncertainty because of, for example, low local gas velocities, time-varying thermal-radiation exchange between a thermocouple and its warmer and/or cooler surroundings, and thermocouple surface emissivity changes caused by oxidation and soot accumulation. Large thermocouple beads, often used to provide ruggedness, are unable to monitor fluctuating gas temperatures accurately because of their poor response times. Proposals are solicited for innovative gas-temperature measurement techniques for use in and around fires which are more accurate and possess better temporal resolution than thermocouples. New methods should be able to rapidly measure local gas temperatures somewhere in the region between 3000 and 20000 K in a fire environment. The temperature probe should be rugged and possess calculable precision and accuracy.

8.8.4T Subtopic: Advanced Fire Suppression and Novel Suppression Concepts

Fire protection of facilities requires suppressants that will not harm the environment nor cause excessive collateral damage to a structure or its contents. The need for alternatives which have low toxicity constrains one's choice of chemicals even more, suggesting that improved means for storage and delivery of less effective (but inherently safe) materials need to be addressed. Proposals are solicited which will improve any aspect of automatic fire suppression systems, such as more efficient storage of the agent, timely and precise delivery to the space being protected, enhanced interaction of the agent with the fire, and minimal negative interaction with the surroundings. Means to evaluate novel concepts at a reduced-scale which reliably predict full-scale operation should be addressed in the proposal. Methods to enhance the effectiveness of inert gas systems and fine water sprays as fire fighting agents and overcome their deficiencies (large quantity requirements and possible asphyxiation for inert gases, and significant collateral damage for water sprays) are legitimate topics. Other currently proposed halocarbon substitutes

for halons are saddled with known or potential negative impacts on stratospheric ozone depletion or global warming, and it is unlikely that new compounds from this family will have both short atmospheric lifetimes and zero ODP. Approaches to more precisely predict the chemistry of alternative compounds in the atmosphere and to hasten their conversion to the most environmentally-friendly end-state are also sought. Refer to related descriptions in annual summaries of BFRL research.

8.8.5T Subtopic: Rapid Time Response Heat Release Rate Sensor for Fire Testing

The release of fire-fighting agents and subsequent extinguishment of accidental fires takes place in time periods as short as tens of milliseconds. Few details are known about suppression under these conditions because few instruments are capable of responding rapidly enough to resolve the behavior of the fire. One measurement which is necessary for studying suppression is the temporally resolved heat release rate of the fuel. The heat release rate is the energy per unit time released by the fuel as it reacts with oxygen. The heat release rate is not necessarily equal to the mass loss rate of fuel; all of the fuel which evaporates does not necessarily burn. Proposals are solicited for a heat release rate meter for liquid pool fires with a rapid temporal response and the capability to resolve fires somewhere in the region between 10 kW to 5 MW. The heat release rate sensor should be rugged and should possess calculable precision and accuracy. Special consideration will be given to meters which can monitor the heat release rate while the fire and fuel pan are interacting with an overhead extinguishing agent release.

8.9 NIST TOPIC: COMBINATORIAL DISCOVERY OF MATERIALS AND CHEMICALS

8.9.1T Subtopic: Advanced Technologies for Combinatorial Discovery of Materials

The amalgamation of computer hardware, information technologies, improved sensors, “smart” robotics, and computational chemistry software now facilitates the rapid discovery of new chemical targets for the pharmaceutical industry. The need for “combinatorial” (also known as “high through-put” or “massively parallel”) research is obviated by the global time-based competition that is driving innovation toward ever-reduced commercialization cycle times. Discontinuous innovation leading to successful implementation of combinatorial methods will result from the fusion of an emerging technology infrastructure among otherwise diverse technology suppliers. This technology fusion will occur in the domains of the hardware and software industries and will be directed toward solving specific problems in various industries, such as polymers, catalysts, smart materials, electronic materials, specialty & fine chemicals, biomaterials, optical materials, glass formulations, and structural materials. Technology hurdles are industry-specific: many technological problems are being solved in some application areas (for example, electronic materials and catalysts) while other applications are awaiting enabling technologies.

Combinatorial discovery could accelerate materials discovery to unprecedented levels in the more conservative industries. However, these industries will accept the new methodologies only after a significant growth in the supporting, or infrastructural, technologies reduces the risks of entry. Proposals are solicited in the following areas: **Database/Informatics (**Patent and prior art reviews, Search engines/Inferential Engines, Indexing, Entity Inventory, Electronic Laboratory Notebook); **Library Validation** (Molecular Modeling, QSAR. QSPR, etc.); **Library Design (**Statistics, modeling, design of experiments, Reagent Building Block Analysis, Literature/Patent Databases, Diversity analysis/clustering/analysis, Computational: Molecular Modeling, Atomistic Simulations, QSAR, QSPR); and **Decision Tools (**Structure Activity/Property Relationship Tools, Prioritization, Promotion analysis & tools). Small businesses, in particular, can therefore make a meaningful impact in the implementation of combinatorial R&D in large industries.

8.10 NIST TOPIC: CONDITION-BASED MAINTENANCE

8.10.1T Subtopic: Development & Integration of Condition-Based Maintenance Technologies

Improved maintenance programs are often overlooked as an incredibly powerful way of increasing a manufacturing facility's profitability. These profits can be realized in part by taking maintenance programs from a reactive or time-based approach to one that is based on determining the condition of equipment and estimating its remaining useful life. Such condition-based maintenance programs require the development of technologies that go beyond diagnosing equipment problems, but instead monitor the equipment and continually access its health.

To address the developmental needs of new technologies for condition based maintenance, proposals should address one or more thrust areas deemed necessary for the promotion of prognostication capabilities. These thrust areas are: developing capabilities to predict, and to continuously refine the prediction of, remaining useful life of equipment (failure models, new statistical tools for prediction, data correlation for multiple monitoring systems, reduction of data to useful information); new sensor technologies (smaller, inexpensive, and able to be built into equipment for continuous monitoring); and expert systems for maintenance-related knowledge and advice (integration of condition-based maintenance technologies with existing computer-based maintenance programs, procedures, history, and training).

8.10.2T Subtopic: Low-power Wireless Intelligent MEMS-based Sensors

In flexible integrated manufacturing systems, intelligent sensors play a key role. These sensors are essential components in closed-loop manufacturing systems and can improve product quality as well as production efficiency. In order for sensors to be widely used in manufacturing

systems, the intelligent level of sensors has to be increased and the price of sensors decreased. Similar to the production of semiconductor chips, MEMS-based sensors can be manufactured in a batch mode. Thus, MEMS-based sensors could potentially lead to lower unit costs. When integrated with microprocessor technology, the intelligence of these sensors can also be enhanced. Wireless sensors communicate with their host unencumbered by cabling. This feature, in some situations such as in a rotating spindle, grinding wheel, or in a hazardous environment, can ease the integration of sensors into systems and applications. If lower power consumption can be achieved on these sensors and their associated electronics, the energy scavenge technique can be used to free users from the burden of periodic battery replacements in these devices.

NIST is working with IEEE and industry to standardize communications interfaces for smart sensors. Hence, we solicit proposals for the development of smart sensors and communication protocols mentioned above that can measure acceleration, air and fluid flow, temperature, pressure, vibration, etc. These low-power, wireless, intelligent MEMS sensors should be easily integrated with the proposed IEEE P1451 family of standards. It is recommended that the proposing party be thoroughly familiar with proposed IEEE P1451 family of standards. Copies of the standards and draft documents can be obtained from IEEE at 1-800-678-4333.

Note: It is expected that a Phase 2 effort will result in the construction of a prototype.

8.11 NIST TOPIC: INTELLIGENT CONTROL

8.11.1T Subtopic: New Ultrasonic Electrostrictive Copolymer Transducer

Piezoelectric materials possessing increased electromechanical efficiency at megahertz ultrasonic frequencies are constantly being sought for improved transducers and sensors and actuators with application to materials evaluation, product testing, medical diagnostics, etc. A principal mission of the NIST ultrasonics group in the Manufacturing Engineering Laboratory is the development and analysis of transducers with broad application to nondestructive evaluation. For example, an area of recent research has focused on the development and performance study of a lensless line-focus transducer based on thin piezoelectric polymer (PVDF), and copolymer, films.

The discovery in 1997 of a new class of relaxor ferroelectric copolymers has generated a significant potential for much improved transduction efficiency with these flexible plastic materials in the generation and detection of ultrasonic-frequency mechanical waves. It is the purpose of this subtopic to determine the usefulness of these electron-irradiated electroacoustic P(VDF-TrFE) copolymers as transduction devices at megahertz frequencies. Knowing the material transduction behavior as a function of frequency up to tens of MHZ, as well as supportive modeling, would be useful. The response and bandwidth of the material for short (fractional period) pulse excitation is also of interest.

The focus and ultimate purpose of this program to develop prototype ultrasonic transducers that would take advantage of the improved sensitivity and bandwidth performance of these new electroacoustic copolymers. Specifically, it is to utilize these advanced piezoelectric materials in a packaged transducer for pulse-echo operation in conjunction with off-the-shelf electronic instrumentation used by the ultrasonic nondestructive testing community. Substantially increased sensitivity and bandwidth at MHZ (and preferably tens of MHZ) frequencies are sought for the prototype transducers, as compared with the polymer-based transducers which are presently available.

8.11.2T Subtopic: Sensor-based Electronic Enhancement of Electrodynamic Actuators For Accelerometer Calibration

The Acoustics, Mass, and Vibration Group calibrates accelerometers and undertakes the complete design of accelerometer calibration instrumentation, including both actuators and sensors e.g., laser interferometers. To retain its standing in the standards community, and meet the increased needs of emerging industrial sectors (next generation vehicle technology; advanced process control for flexible integrated manufacturing), the Group must improve the accuracy and current range of its low frequency (1 Hz to 50 Hz) calibration facilities. A principal goal is to extend current capabilities to cover the range 0.1 Hz to 50 Hz at 0.25 % uncertainty. The accuracy and frequency ranges of present calibrations are limited by the performance of the electrodynamic actuators (shakers) which provide the mechanical input to the accelerometers under test.

Dictated predominantly by fundamental physical constraints, the designs of electrodynamic actuators (shakers) used to calibrate accelerometers have changed only slightly in recent years. In particular, the nonlinearities intrinsic to elastic and magnetic design elements have so far been addressed exclusively by careful and elegant adjustments of key design parameters. Though of unquestionable robustness, this passive open loop approach cannot exploit the capabilities of modern sensors and readily implemented electronic signal processing techniques. Incorporation of position sensors and electronic feedback into new designs for electrodynamic shakers will substantially improve the accuracy of accelerometer calibration by reducing harmonic distortion and cross-axis motion, and will also extend operating envelopes by increasing the useable stroke. We seek proposals for collaborative research efforts to design and construct an electrodynamic shaker capable of 3 cm to 1 m displacement for corresponding frequencies 50 Hz to 1 Hz, harmonic distortion less than 0.5%, and cross axis motion less than 0.5.

8.11.3T Subtopic: Graphical Design of Manufacturing Control Systems

We invite proposals for the development of a tool to enable the graphical and iterative design of a manufacturing control system, from the concept stage through code generation. In order to maximize the productivity of the system designer, the tool should also provide guidance in architectural design by guiding the user according to a set of architectural design rules. One such set of architectural design rules is defined in the Intelligent Systems Architecture for

Manufacturing (ISAM), being developed at the National Institute of Standards and Technology. ISAM is a hierarchical architecture that encompasses planning and execution for various levels within an enterprise within a unified framework. ISAM and the related 4D Real-Time Control System (4D/RCS) architecture have been used successfully in a number of complex systems. An extensive RCS software library is available for downloading at our web page.

We are interested in a tool set that is an aid to laying out the hierarchy and decomposing the tasks and resources for a specific application, while following architectural guidelines. This tool would enable top-down, bottom-up, and/or iterative design of a control hierarchy, starting from a conceptual view, i.e., without requiring the user to specify details at the beginning, yet providing guidelines or constraints that would help users build ISAM-compliant systems. This tool would let the user sketch the boxes, i.e., ISAM nodes, and interconnections that define the system, but would not require precise definition of data structures that pass between boxes. Examples of elements of ISAM-compliance would be one supervisor per subordinate, cyclic execution, command and status interfaces between superior and subordinate, and following timing guidelines for each level of execution. The user would be able to refine the hierarchy and add detail as the design evolves. Once the user has added all the necessary detail to the hierarchy, the tool should be able to verify consistency (e.g., all nodes receive commands and return status). At minimum, the tool will generate interface files or C++ class definitions.

NIST is soliciting proposals for development of a prototype system that enables iterative, top-down, and bottom-up design of a manufacturing control hierarchy following the ISAM guidelines. Phase 1 deliverables should include a design for a tool that supports graphical design and code generation capabilities, given ISAM architectural constraints.

Note: It is expected that a Phase 2 effort will result in the construction of a prototype.

References:

Internet site: http://isd.cme.nist.gov/documents/albus/Int_Sys_Arch_Manuf.pdf

Internet site: http://isd.cme.nist.gov/documents/albus/demo3.pdf

Internet site: http://isd.cme.nist.gov/proj/rcs_lib/

8.11.4T Subtopic: Simulation and Animation Tools Supporting RCS Control Systems Development

The NIST Intelligent System Division (ISD) has been conducting research in intelligent systems and developing the Real-time Control System (RCS) reference model architecture for about two decades. This work is aimed at developing a theory of intelligence, advancing the state-of-the-art in intelligent control, and providing and open-systems framework for investigating proposed interface standards and performance metrics. The Intelligent System Architecture for

Manufacturing (ISAM) and 4D/RCS are two instances of RCS targeted for the manufacturing and autonomous vehicle control systems domains, respectively.

NIST ISD has embarked on a generic shell approach to facilitate development of 4D/RCS and ISAM applications. This approach entails development of a toolset, written in C++ code, following the generic architectural principles of the RCS model. The toolset provides facilities for developing and integrating application specific control and knowledge algorithms and task entities to form a complete working controller. The RCS generic shell software also contains embedded communications functions that are mostly transparent to the end users. An extensive library of existing RCS software and documentation is available for downloading from our web page.

ISD seeks software simulation and animation tools to augment the RCS generic shell software libraries. Simulation and animation (S&A) tools are needed to facilitate design debugging and testing of controller applications developed using the RCS generic shell toolset. The S&A toolset should seamlessly interface with RCS controller modules built using the generic shell approach at every level of the RCS hierarchy. The S&A toolset should embrace and complement the RCS principles of: hierarchical structure, openness, modularity, standard interfaces, and levels of granularity in time and space. Graphic animation rendering tools for human visualization of the design behavior can be regarded as separate from the simulation algorithms. Design of the S&A toolset is the primary task for this topic. Development of the S&A algorithms is beyond the scope of Phase 1.

Key desired capabilities of the S&A toolset include compatibility with the RCS generic shell toolset, support for multiple levels of resolution (i.e., different time scales and spatial spans), openness, modularity, ease of use, and the ability to evolve its functionality over time. The S&A toolset should be capable of interacting with a hierarchical control system application at all the control levels. Some brief examples follow. When testing a control system at the lowest level, the S&A toolset should be able to receive the actuator controller output signals, compute the actuator movements, and graphically render its movements in simulated real-time. These simulated movement values should be integrated in the hierarchically structured simulator to form high-level system perceptions, such as machine or vehicle positions and motions. The simulation results are fed back to control hierarchy via simulated sensors, as a part of the control system. Simulation interfaces that interact with higher levels of abstraction in the controller should also be supported. For example, at the RCS subsystem level, the simulator should be able to receive the corresponding controller output commands, such as kinematic path way points for robotic arms or intelligent autonomous vehicles. The simulator should then be able to compute the kinematic effects of the commands, generate the responses, and also integrate the responses at higher levels of the simulator hierarchy to form corresponding perceptions. At the same time the animator should be graphically rendering the machine motions being simulated in simulated real-time on a computer graphics monitor.

A key to the development of open and modular S&A software is the Application Programmers Interfaces (API) development. The S&A toolset should support multiple-level interactions with an RCS control system in real-time. Using the toolset to develop an S&A application will require characterization of the application domain, and development and integration of the S&A application modules--using the API set--with the corresponding RCS control modules at appropriate hierarchical control levels within the controller.

Simulation software developed using the S&A toolset should be modular in the sense that the algorithms for computing the physical entity responses will be separate from those for graphic rendering of such responses. The animation software should be graphical and either real-time or near real-time. The S&A applications software is modular also in the sense that the modules can be easily integrated, disabled, bypassed, or deleted from the system.

References:

Internet site: http://isd.cme.nist.gov/documents/albus/Int_Sys_Arch_Manuf.pdf

Internet site: http://isd.cme.nist.gov/documents/albus/demo3.pdf

Internet site: http://isd.cme.nist.gov/proj/rcs_lib/

8.11.5T Subtopic: Novel Atomizer for Control of Reference Spray Combustion Facility

Control of chemical liquid waste combustion depends critically on the quality of droplet atomization, and mixing of wastes within the surrounding air flow field. A reference spray combustion facility is under development that will be used to provide benchmark experimental data. The facility will be well characterized, and provide standards for spray systems, instrument calibration, and validation of computational fluid dynamic models. Of critical need for this facility is an atomizer that will serve as a repeatable reference standard for intelligent control of the facility. A variety of methodologies can conceivably be applied to ensure optimum atomization and control. Novel strategies are sought to provide a well-controlled spray that has a known size (polydisperse) and velocity distributions, as well as predictable droplet transport properties (i.e., dispersion and penetration) and residence time under burning conditions. An atomizer is needed that will: (1) produce different *a priori* specified droplet size and velocity distributions, with known number densities (Sauter mean diameters between 7 and 200 μm and densities of up to $10^6/cm^3$); (2) be applicable to high-temperature operation (combustion); and (3) produce droplet velocities up to 30 m/s, and iv) use conventional fuels (e.g., kerosene) at flow rates of up to 10 l/h.

Phase 1 of this research should demonstrate the feasibility of the proposed approach. The objective of Phase 2 is the delivery of a functioning device. It is expected that the availability of

a controllable spray nozzle will find immediate commercial applications in spray nozzle and burner industries.

8.11.6T Subtopic: Materials Processing to Control Toughness

NIST's Standard Reference Materials Program currently supplies carefully processed and characterized impact specimens for the evaluation of the performance of Charpy impact machines. The quality of these specimens is carefully controlled since the scatter due to materials variation obscures the evaluation of the machine performance. Further reduction in the scatter promises increased insight into machine performance factors and earlier detection of machine wear or degradation on performance.

The current specimens are produced from heat lots of quench and temper (AISI type 4340) or precipitation hardening steels, produced to NIST refining and rolling specifications. The steels are then machined and heat treated to produce the desired properties. NIST has master Charpy impact machines that are used to evaluate each batch of specimens and determine a mean energy and standard deviation. We are searching for information on alternate materials and heat treatments to produce standard sized (10 by 10 by 55 mm), notched specimens that have the minimum standard deviations in impact energy. Specifically we wish standard deviations smaller than 0.7 J for specimens with a mean energy near 18 J and standard deviations less than 3% at mean energies near 100 and 200 J.

8.11.7T Subtopic: Process Monitoring and Control of Composites Processing

Composites manufacturing is a growing industry in the United States. However, quality control issues threaten to limit the growth of the industry in high production volume commercial sectors such as automotive. Inconsistency in part quality arises from a large number of sources, including catalyst, mixing, and resin variabilities. Another important source of inconsistency arises from flow variability caused by fiber preforms that do not perfectly fit mold contours. Process monitoring and control are expected to improve quality and drive down production costs.

Researchers at NIST have developed prototype optical fiber sensor systems for fluorescence and near IR monitoring of composites processing in response to industry needs for improved process control. NIST seeks proposals to explore the usage of optical fiber process monitoring systems for process control in liquid molding or pultrusion manufacturing environments. Proposals are also sought to refine, ruggedize, and miniaturize the optics and detector systems.

The current optical fiber fluorescence system can obtain complete spectra in under 0.1 s, in either distal or evanescent wave sensing mode, and has been laboratory tested with epoxy, polyurethane, and isophthalic polyester resins. The optical fiber near IR system uses the same inexpensive fiber as the fluorescence system, and is currently implemented with a standard FTIR. Evanescent wave near IR spectra are obtained in less than 4.5 s.

The following NIST patents are related to this subtopic:

NIST #93-061, U.S. Patent #5,519,211 "Method And Apparatus For Monitoring Resin Crystallization And Shrinkage During Polymer Modeling"

NIST #90-031, U.S. Patent #5,384,079 "Method For Detecting Thermodynamic Phase Transitions During Polymer Injection Modeling"

NIST #89-015, U.S. Patent #5,151,748 "Optical Sensor For The Measurement Of Molecular Orientation And Viscosity Of Polymeric Materials Based On Fluorescence Radiation"

NIST #95-011, U.S. Patent #5,598,005 "Nondestructive Method For Determining The Extent Of Cure Of A Polymerizing Material And The Solidification Of A Thermoplastic Polymer Based On Wavelength Shift Of Fluorescence"

NIST #96-017, U.S. Patent Pending "Method And Apparatus For Measuring The Temperature Of A Liquid Medium"

8.11.8T/CC Subtopic: Constitutive Equations for Lightweight Sheet Metal Forming

Increased use of lightweight materials in automobiles is essential to the achievement of PNGV goals for improved performance. The PNGV Manufacturing Team has identified reliable and predictable aluminum forming as one of the top 5 priorities in vehicle manufacturing needs. Industrial experience with lightweight materials is limited and the use of computer methods (for example, finite element analysis, FEA) to predict forming behavior is being actively pursued by industry to accelerate the transition from traditional alloys. FEA employs constitutive equations to relate stress and strain. However, for the large strains and nonproportional loading paths occurring during and after sheet metal forming, presently employed constitutive equations are inadequate. Advanced equations that more accurately predict the mechanical behavior of metal undergoing large strain plasticity need to incorporate internal state variables. We seek the development of equations incorporating measurable, physically based state variables (for example, parameters describing dislocation structures). It must be demonstrated that effective techniques exist or can be developed for measurement of these variables and the internal state of deforming metals. Such an approach is likely to be useful in a variety of commercial applications ranging from the determination of residual stress to metal forming.

8.11.9T Subtopic: Sensor for In-Situ Measurements of Thermal Spray Coatings

Thermal spray coatings are becoming more important as manufacturers simultaneously search for techniques for cutting costs and giving their parts and products greater reliability and wear resistance. To succeed, the manufacturers require measurement and diagnostic tools to better understand and control their processes. A sensor that gives more accurate temperature

measurements, provides an indication of changes in texture (emissivity), and also gives an indication of coating quality, would be important in extending the applicability and reliability of thermal spray coatings. Researchers at NIST require a sensor or sensors to make localized measurements of temperature, emissivity, texture, and coating quality of thermal spray coatings. This sensor is to operate during the thermal spray coating production process, and is to be usable for feedback and control of the thermal spray process. One promising approach is the use of an optical fiber thermometer in conjunction with multicolor pyrometry and simultaneous reflectance monitoring. NIST holds U.S. Patent #4,576,486 "Optical Fiber Thermometer" which may be applicable and is available for nonexclusive licensing. NIST will entertain proposals that address the major elements of this measurement problem within the described framework. Ideally, the sensor would be an innovative adaptation of tried and proven technology, so that it is immediately ready to secure the required data, and is likely to succeed as a feedback and control sensor.

8.11.10T Subtopic: High-Speed Video Camera for Measurements in Spray Processing

Advanced, user friendly, high-speed (50-100 ns frame exposure time) electronically shuttered camera systems are needed to further investigations of material spray processing such as DC and RF plasma spray coating, metal spray forming, atomization, etc. These processing technologies are now used (or are planned to be used) to provide necessary advanced materials for military, aerospace, automotive, and numerous other civilian applications.

The required video camera system would allow multiple (two or more) exposures per video frame with effective exposure times less than 100 ns for each frame. Framing rates should be on the order of standard video (~30 fps), however, slower framing rates (1 fps) with adequate multi-exposures per frame would be useful. This capability would allow vital measurement and diagnostic studies of dynamic phenomena within material spray equipment including particle size, velocity, and the distribution of these within the spray. Spatial resolution must be better than 20 μm with focal length adequate to insure that the harsh processing environment will not damage the optical components (telephoto/macroscopic optics). The system hardware should be suitable for an industrial materials processing environment and should be available to industry at a cost less than $45K.

Processing improvements realized from use of an ideal camera system as described above would lead to substantial improvements in deposition efficiency and could lead to the use of spray deposition in producing new materials and/or new products with better properties and reduced cost.

8.11.11T Subtopic: Laser Light Source for Illuminating Specularly Reflecting Droplets

A visible light source is required to illuminate the droplets in spray plumes generated by metal atomizers, metal spray deposition equipment, plasma spray coating systems, etc. The particles

and droplets generated by these processors are generally 5 to 100 μm in diameter and travel at velocities up to several hundred m/s. The specularly reflective surface of these "droplets" renders point source and collimated light unsuitable for the required "reflected-light" imaging of surface structure. This light source will be synchronized with a high-speed movie camera (10,000 fps) where each frame will be exposed with one or more short duration (<100 ns), flash illuminated images through "telescopic/macro" optics. Copper Vapor (CV) lasers with external sync oscillators capable of 15 to 20 watts of light output with a fiber optic couple to a beam expander and Lambertian scattering plate should provide sufficient brightness and dispersion for this application. Other laser or white light sources would be considered if the wavelength, pulse duration, and repetition rate were suitable for high-speed film exposure.

8.11.12T Subtopic: Improved Magneto-Optical Indicator Films

The magneto-optical with indicator film (MOIF) imaging technique is a non-destructive method for real time characterization of magnetic domain structure for wide range of technologically important magnetic materials such as spin-valves, ultrathin multilayers, and granular systems. The MOIF film is placed on top of a magnetic sample and has its magnetization altered by the magneto-static field of the sample under study. In this way, the domain structure of the sample under study is imaged in a polarizing microscope through the interaction of polarized light with MOIF film. The MOIF method is expected to become a standard non-destructive quality control imaging technique for the next generation of magnetic materials for sensors and storage devices. Proposals are solicited for the development of improved magneto-optical indicator films, including, but not limited to, transparent Bi-substituted yttrium-iron garnet single-crystal films (thickness 1 - 3 micrometers, Faraday rotation > 100,000 deg/cm) with a reflective Al underlayer grown on a gadolinium-gallium garnet substrate. The influence of different element substitutions should be studied to enable films with different magnetic saturations and sensitivities to be fabricated.

Reference:

Gornakov, V. S., V.I. Nikitenko, L.H. Bennett, H.J. Brown, M.J. Donahue, W.F. Egelhoff, R.D. Mc.Michael and A.J. Shapiro, "Experimental Study of Magnetization Reversal Processes in Nonsymmetric Valve." J. Appl. Phys. 81. (8) 5215, 1997.

8.12 NIST TOPIC: INTELLIGENT AND DISTRIBUTED CAD

8.12.1T Subtopic: CAD and DMIS Integration of Virtual CMMs

A principal determinant of quality in the manufacturing of discrete-part products is the ability to manufacture and verify the conformity of machined part features. Additionally, measurement traceability requires the assessment of measurement uncertainty for all measurement results. Thus the rapid and efficient generation of both CMM inspection instructions and task specific measurement uncertainty statements is imperative. This solicitation seeks innovative flexible

integrated manufacturing concepts to combine CAD based CMM inspection software capable of generating DMIS 3.0 output with virtual CMM simulation software capable of producing task specific uncertainty statements compliant with ANSI/NCSL Z540-2 1997. The result of this effort should yield a seamless software package capable of highly reliable collision free DMIS based CMM instructions and on demand task specific measurement uncertainty statements for any feature or GD&T analysis included in the DMIS output.

Both the CAD directed inspection and the virtual CMM simulation should be capable of modeling real industrial conditions, including (but not limited to) many different types of CMMs, probes, probe heads, sampling strategies, environmental factors, operator effects, and the myriad of errors present in manufacturing and measuring equipment. The software should be based on data that is practically and economically obtainable in an actual factory environment. This includes the ability to generate inspection programs and produce task specific uncertainty statements for parts defined in any of the common CAD or solid model representation currently in industrial use. The system should be capable of operating on standard Win 95/NT type computer platforms.

8.12.2T Subtopic: Computational Tools to Support Intelligent and Distributed CAD

Design of complex engineering systems is increasingly becoming a collaborative task among designers or design teams that are physically, geographically and temporally distributed. The complexity of modern products means that a single designer can do no longer manage the complete effort. Designers are no longer merely exchanging geometric data, but more general knowledge about design and design process, including specifications, design rules, constraints, rationale, and more. As design becomes increasingly knowledge-intensive and collaborative, the need for intelligent CAD tools to support the representation and use of knowledge among distributed designers becomes more critical. The objective of this solicitation is a development of computational tools to support intelligent and distributed CAD (IDCAD), or more specifically, frameworks for distributed design that will improve the ability to represent, capture and reuse design knowledge, and to enable design integration across time and space. Examples of challenges associated with IDCAD include but are not limited to knowledge-based CAD, knowledge capture and sharing, supply chain management, Internet-based communication, novel design agents, etc. An emphasis will be placed on tools that are either compatible with hardware/software platforms used by small to medium enterprises, or accessible from such platforms (e.g., via the Internet).

8.12.3T/CC Subtopic: Green Engineering Concepts for Next Generation Vehicles

Environmental regulations on CFC and HCFC's have put considerable pressure on automotive designers to develop newer designs of air conditioning systems. The use of carbon dioxide as a refrigerant is not new. At the turn of the century most refrigeration systems were carbon dioxide based and more compact freon-based systems eventually replaced them. Currently, there is considerable interest in carbon dioxide based systems. By going to higher pressures, it has made

carbon dioxide as a more effective refrigerant. The use of carbon dioxide as a refrigerant would be a great boon to the environment. Carbon dioxide costs 1/100th the cost of a non-ozone depleting freon and is readily available everywhere. More importantly, it does not require any great freon capture machinery in an automotive garage. There are other such examples of design for the environment. However, the big issue is the engineering design. Proposals are solicited that will utilize advanced CAD tools (such as network-centric CAD, novel design exploratory tools) for developing designs that will not only be simple, but easy to manufacture taking into consideration the life cycle concerns of the product.

8.13 NIST TOPIC: INFRASTRUCTURES FOR DISTRIBUTED ELECTRONIC COMMERCE

8.13.1T Subtopic: XML for Workflow Management

The increasing prevalence of virtual enterprises is driving a need to coordinate the efforts of individuals and teams using different computer platforms residing on different local area networks. Such coordination often requires the exchange of complex data objects between distributed applications. The Web has become a popular computing environment for virtual enterprises because it allows users on heterogeneous platforms to use the same applications and access the same data. The emerging XML standard provides a convenient and cost-effective way to define structured data objects to be shared among distributed tasks and applications on the Web.

NIST is soliciting proposals for the applications of XML and Web technology to workflow management systems. The result of this effort shall be the development of a software tool-kit for building Web-based workflow applications employing XML as means for data exchange. The only software required of end users to run workflow applications developed using the tool kit shall be a Web browser that supports XML.

References:

Internet site: http://www.w3.org/XML/

Internet site: http://www.aiim.org/wfmc/

8.13.2T Subtopic: Internet-based Manufacturing

U.S. manufacturers face unprecedented challenges and opportunities in the operation of information-based enterprises. The manufacturing industry is increasingly operating on a model of production in which Original Equipment Manufacturer's (OEM's) assemble products out of components produced by a network of widely distributed suppliers. This model is emerging into one in which manufacturing operations are treated as distributed services accessible via the Internet. The use of the Internet by OEMs to locate, contract, link, and even execute manufacturing services offers improvements in cost, cycle time, and quality. The current

opportunity is afforded by advances in several areas: (1) industry and government researchers are defining the Next Generation Internet to enable secure, dedicated bandwidth to its users, (2) electronic commerce protocols are emerging rapidly and through increasing use are becoming more effective, (3) standards are emerging for distributed object-oriented software systems that describe interfaces to manufacturing objects, and (4) emerging approaches to Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES) hold the promise of new gains in manufacturing efficiencies.

We solicit proposals to develop software and openly specified protocols that addresses all or part of the following:

1. Integrate distributed MES and ERP components across manufacturing enterprises.

2. Develop new niche software components with openly specified interface definitions that fit within broader MES and ERP frameworks.

3. Combine Electronic Commerce protocols with distributed object protocols to publish, subscribe, and contract for manufacturing services.

4. Develop formal models of information and process needed to integrate manufacturing software components.

5. Provide software tools and openly specified protocols that enable manufacturing customers to specify, order, and pay for custom manufactured products in a way that drastically reduce production cycle times.

6. Apply advances in distributed object technology, advanced process control and simulation to establish a new network-based manufacturing paradigm.

7. Provide proof of concept demonstrations to reduce risk of adopting the paradigm of distributed, Internet-based manufacturing services.

8. Provide metrics for inter-comparison and adoption of technologies enabling Internet-based manufacturing services.

It is recommended that proposed efforts leverage existing work in the research community on electronic commerce, distributed object systems, Manufacturing Execution Systems, and enterprise integration. Web sites for material referenced above include: (1) NIST Manufacturing Engineering Laboratory, Manufacturing Systems Integration Division: www.nist.gov/msid; (2) CommerceNet: www.commerce.net; (3) Object Management Group: www.omg.org; (4) National Industrial Information Infrastructure Protocols: www.niiip.org.; and (5) SEMATECH CIM Application Framework: www.sematech.org/public/cim-framework/home.htm.

8.13.3T Subtopic: Secure Agent-Based Electronic Commerce

Intelligent and Mobile Agents acting on behalf of individuals and organizations present several opportunities for their use in electronic commerce. These technologies can be directly applied to electronic commerce in several areas, including: Electronic Market Places, Electronic Auctions, Brokering and Trade-mediating Services, Virtual Trading Institutions, Network-based Tendering and Procurement, Agent-based Negotiation, and Agent-based Contracting. The power of Agents, however, raises several privacy, accountability, and security concerns. The security concerns related to Agent systems is clearly one of the main obstacles to the widespread use an adaptation of this new technology. Agent security issues that need to be resolved include: authentication, identification, secure messaging, certification, trusted third parties, non-repudiation, fault-tolerance, and privacy. The goal of this effort is to develop innovative and secure electronic commerce applications that will take advantage of agent technology.

8.13.4T Subtopic: Multiple Security Policy Toolkit

Most large-scale software applications have a variety of diverse, security needs. Some of them will implement a Chinese Wall security policy, others might implement the Brewer-Nash policy, while yet others may implement specialized policies. Hence there is a need for a framework within which different distributed database and software applications can flexibly choose what security policies they wish to apply to their application.

The goals of this effort are:

1. Define an efficiently implementable, yet sufficiently expressive security language through which, application developers may express their security policies. Show that the language is expressive enough to express many of the commonly used security policies in existence today. A logic-based language may be considered for meeting this objective.

2. Design, develop, and implement a prototype demonstrating the proposed concept or technology. This prototype will provide a graphical user interface that may be used by the application developer, thus avoiding the need to learn the above language. The interface will directly generate code in the target language. The toolkit will thus enable application developers to declaratively state their application's security needs, and be guaranteed that the toolkit will automatically implement their security needs.

8.13.5T Subtopic: Natural Language Interface to 3-D Character Animations

The use of animated human or human-like characters to supplement voice and text communication has long been recognized as a means of improving the motivational response to and/or clarity of multimedia presentations. When media presentations are prepared off-line, it is possible to develop predetermined 2-D character animations that convey specific meanings. This method does not work, however, when the character must interact to user responses with a shorter duration between events than the length of the animations, or when the character must be

viewed interactively from multiple viewpoints. In these cases, a real-time 3-D representation of the character is required. Such 3-D characters have been used in multi-user web-based environments enabled by the emerging Virtual Reality Modeling Language (VRML). However, the expressions and/or gestures of these "avatars" have lacked visual realism and have been directly controlled as a response to a user selection from a small set of pre-defined actions. In addition, control of human simulations which follows the Humanoid Animation Working Group (HANIM) of the VRML consortium is desired to improve portability and interoperability of systems. What is needed is a character that responds with enhanced realism to user or simulation initiated events.

8.13.6T Subtopic: Improved Noise Robustness and Speech Detection for Large Vocabulary Continuous Speech Recognition (CSR) Technology

Current state-of-the-art CSR systems experience degradation of performance in the presence of background noise, especially when using other than head-mounted microphones. Current systems also cannot reliably discriminate between background noise and speech in background noise. Improved technology is needed to improve noise robustness for both continuous (stationary) and impulsive noise, and to discriminate between speech and noise. Ideally, the improved technology would permit reliable use of CSR technology with low-cost, remotely positioned microphones, and eliminate reliance on the use of push-to-talk microphones. This technology should also be valuable in automatic transcription and indexing of radio and TV broadcast materials, especially those portions of the broadcasts originating in other than broadcast studios.

8.13.7T Subtopic: Role Engineering for ERP Applications Using RBAC and Its Extensions

Enterprise Resource Planning (ERP) systems are being increasingly deployed in many organizations. These systems contain one or more functional modules for each of the various areas of enterprise like Manufacturing, Financials, Sales & Distribution. The maximum benefit from these modules can only be realized if their functions can be integrated to implement a total business system. To achieve seamless integration of these various modules, it is necessary that organizations develop an enterprise-wide business data and process model.

One of the essential components of this business model is the definition of areas of responsibility and accountability for individuals and groups within the organization so that the integrity, availability and confidentiality of the information resources of the corporation are maintained at a satisfactory level of confidence. Roles provide a mechanism for meeting the above objective. RBAC relies on the mechanism of roles to implement various access control rules for the enterprise and hence can be used as a primary vehicle for the role engineering tasks for ERP module implementations.

However the roles in a business data model have to cover several different products, resources, work centers and sometimes several plants as well. Hence the multi-dimensional nature of roles

in ERP applications requires a completely different role engineering strategy than the ones that are used in the present RBAC implementations.

The goals of this effort are:

1. To develop a Role Engineering Strategy that will capture all the complex relationships among roles for ERP applications.

2. To develop an expert system tool with a Graphical User Interface that will assist in the Role Engineering effort for ERP applications.

3. To develop an access control rule generation tool that will use the Role Graph developed by the above tool to actually implement access control policies in the various ERP modules.

8.13.8T Subtopic: Telecommunications System Intrusion Detection

Telecommunications systems are increasingly controlled and managed by commercial computer hardware, software, and techniques. This means that the system is increasingly vulnerable to acts of vandalism and sabotage by hackers, terrorists and other malicious people. Individuals or computer programs that perform such unauthorized modifications to the system are referred to as "intruders." Systems that identify the presence or actions of such intruders are referred to as "intrusion detection systems." Such systems have been used for a number of years in systems on the Internet, although they are rarely used on standard telecommunications networks. NIST wishes to support an effort to develop an intrusion detection system for use in telecommunications networks. This will require the contractor to be familiar with telecommunications networks and control systems as well as conventional computer network intrusion detection techniques. The contractor should identify sources of information, such as audit logs, and develop software tools to analyze that information. If existing intrusion detection techniques are appropriate to the telecommunications environment, they should be interpreted to apply to that new environment. In addition, new techniques, unique to the telecommunications system should be proposed whenever appropriate.

8.13.9T Subtopic: Development of an Interface-Agile Cryptographic Security Service Model

Traditional security services such as confidentiality, data integrity, and data origin authentication require an underlying support structure that includes cryptographic functionality. In the past, these cryptographic functions have usually been hard-coded into proprietary software and hardware, making it difficult to interchange products from different vendors. However, government and private industry have cooperated to develop specifications and standards for Cryptographic Applications Programming Interfaces (CAPIs) that allow developers to modularize cryptographic services and separate them from applications software. It would be ideal if a single CAPI specification emerged as a government/industry standard, but it is not clear

when or if this will happen. There are currently several competing CAPI specifications, so cryptomodule developers are still required to port their products to different APIs.

NIST therefore wishes to support the development of an "interface-agile" cryptomodule prototype, capable of dynamically using different CAPIs depending on the application. This prototype would initially be implemented and tested as a software module, and then ported to a hardware platform. NIST hopes to use the emerging JavaCard™ API for this purpose, since the complexity of this project may require the ability to download executable code (applets) to the cryptomodule.

8.13.10T Subtopic: Displays for Learning Technologies and Information Dissemination

Information technology is providing new and increasing opportunities for present economic growth, where a major portion of GDP comes from information technology products and services. However, future economic growth in this area will result from shifting technologies that focus on information acquisition to knowledge management. A key element for these technologies will be displays that present information in an ergonomic form, and associated technologies that speed learning and comprehension. For example, the integration of display and storage technologies to develop an electronic reader that facilitates increased vocabulary, in-page annotation, voice recognition, and subject correlation would greater enable the future knowledge worker. The goal of this initiative would be the development of technologies that integrate sub-systems (displays, storage media, software, and portable power) leading to robust, and efficient knowledge management in both an office and home environment.

NIST seeks research and experimental implementation to:

1. Evaluate existing human-display interfaces and human information acquisition mechanisms, and determine the degree of present and future standards for human-display interfaces,

2. Develop prototypes that integrate storage, display, and other information transmission technologies, leading to enhanced knowledge acquisition and management over present-day computational and visual platforms; e.g. virtual reality, head-mounted displays.

8.13.11T Subtopic: Security Requirements Analysis, Methods and Tools

Research is being solicited in the area of security-requirements-analysis methods and tools. An important part of NIST's mission includes the definition, analysis, and evaluation of security profiles based on single and multiple sets of standard of security requirements (e.g., those of the Common Criteria for IT Security, FIPS 140 series). The inherent complexity of current distributed systems and networks makes it difficult to rely on informal analyses of security profiles defined for such systems. Distributed system and network complexity is reflected directly into security profile complexity, which in turn increases the analysis and evaluation

effort. At the security profile level, analysis complexity is caused, to a large extent, by the: (1) dependencies among different security requirements in countering a specified set of threats; and (2) wide variety of interpretations and refinements of a requirement in a specific profile. For instance, one can identify hundreds of dependencies among the requirements of the Common Criteria for IT security even when these dependencies are coarsely defined. Refinement of security requirements to meet specific security targets substantially increases the scope and number of these dependencies. Lack of analysis methods and tools for dependency analysis increases both profile analysis effort and the likelihood of analysis error.

The specific areas of research solicited by NIST include, but are not restricted to, the development of methods and tools for the analysis of dependencies among security requirements. Included in this research are: (1) the classification of dependency types; (2) analysis of dependency properties (e.g., transitivity, reflexivity, symmetry); (3) removal of undesirable (e.g., cyclic) dependencies; and (4) analysis of dependencies on requirement composition within security profiles. Also included in this research is the definition of requirement databases and tools for security requirement and security profile definition and analysis.

8.13.12T Subtopic: Testing Methods for Security Properties

Formal methods have been used for many years as a means of verifying the consistency and completeness of product requirements, but rarely for product testing, even though it is possible to produce automated test suites directly from such formal specifications. Unfortunately, the effort involved in producing the formal specifications rivals the effort originally involved in producing the product. As a result, formal verification techniques are rarely used in practice. This initiative recognizes that security related code is often only a small part of the total code in the product. It should therefore be possible to produce formal specifications relating only to the security properties. Ideally, such specifications could be derived from the code itself. There are several reverse engineering techniques that could be used to do this, an example of which is known as "slicing." Slicing is a technique of extracting only those sections of code relating to a particular property. That is, the "slice" behaves exactly like the entire program but only for that property. The goal of this initiative is to investigate the feasibility of slicing (or some other technique), to isolate the security relevant portions of a product, to express security requirements from these slices, and to produce automated tests of those security requirements.

8.13.13T Subtopic: Automated Network Security Administration and Configuration Tools

As the rate at which new products are being introduced into the market continues to increase, so does the complexity of securely administering distributed networks of personal computers, workstations, firewalls, web servers, and routers. Moreover, as new hardware, new software applications, vendor patches and upgrades, and network connections are continuously added to an organization’s network, it is difficult to determine if the system is in a safe-state, and if the organization’s security policy is being properly implemented and enforced. System administrators would benefit greatly from an Automated Network Security Administration and

Configuration Tool that helps them securely configure and maintain distributed systems. These tools could, for example, include network resource discovery routines, track the installation of vendor patches, identify security vulnerabilities, and analyze the organization's security policy to ensure that it is being properly implemented. The goal of this effort is to develop a method for automatically configuring and maintaining the secure state of an organization's network system and a set of support tools that embody the method.

8.14 NIST TOPIC: MEASUREMENT AND STANDARDS FOR CATALYSIS AND BIOCATALYSIS

8.14.1T Subtopic: Single-mode IR Optical Fibers at 4-12 μm

NIST is engaged in a program to develop super-resolution (better than the diffraction limit) vibrational spectroscopies for the study of advanced catalysts. Critical to the success of this program are infrared optical fibers. Desired characteristics of the fibers would be: single-mode, less than 1 db/m loss for operating wavelengths between 2.5-12 μm, with cladding diameters of nominally 125 μm. The fibers should support a minimum of 500 mW of continuous power with damage.

8.15 NIST TOPIC: MEASUREMENT AND STANDARDS FOR COMPOSITE MATERIALS

8.15.1T Subtopic: Methods & Tools to Support Composite Materials for Civil Infrastructure

Quality assurance is needed to continue to catalyze industry efforts in bringing together civil/construction, composites/materials, and chemical/petrochemical industries around key technical challenges that are restricting the efficient rebuilding of our nation for the 21st century. Infrastructure, Industrial Facilities, and Offshore Exploration and Production are among major application areas for composite materials being recommended by industry.

Although composites have been extensively developed and used in the aerospace industry, they need to be developed further in specific directions for use in civil infrastructure applications. In fact, the extent of the use of these applications will depend on areas which include: (1) the resolution of many outstanding issues such as repairability, fire, durability and environmental concerns; (2) the extent to which automation in the manufacturing process can reduce cost; (3) the development of composite material based design concepts that optimize the use of the material; (4) the availability of validated codes, standards, and guidelines which can be used as design references and tools by the civil engineering community; and (5) the degree of quality control and quality assurance which can be developed and provided during the manufacturing/installation phase utilizing unskilled general construction labor. Proposals are desired which support development of the methods and tools for the materials science, long-term durability, development of the reliability database, design methodology and software, low-cost manufacturing technology, and health monitoring technology (smart structure sensors). It is

expected that these efforts will be the basis for advances to create new families of composite materials for the civil/construction, chemical/petrochemical, and offshore deepwater oil and gas exploration industries.

8.15.2T Subtopic: Flaw Detection Method for FRP Composites Used to Repair Concrete and Masonry

Fiber reinforced polymers (FRP) composites are finding new applications in the strengthening and repair of constructed facilities. In these applications, sheets of fiber materials are bonded to the structure using adhesives, such as epoxy resins. Some of the important aspects of quality control during installation are to assure that the proper thickness of FRP reinforcement has been applied and that there are no large voids at the various interfaces created during installation. In addition, it is desirable to be able to assess the integrity of the repair at a later date to ensure that it is performing as intended and that there are no delaminations at the various interfaces. The objective of this solicitation is to develop a nondestructive testing (NDT) technique to be able to measure the thickness of the FRP composite applied to concrete or masonry and detect the presence of voids, delaminations, or loss of bond at the interface with the substrate and at the interfaces between the FRP layers. Infrared thermography has been demonstrated to be capable of detecting delaminations within the FRP layers, but the method suffers from the need for heating of the structure and the sensitivity to ambient atmospheric conditions. For this Phase 1 project, the awardee is expected to assess the state-of-art in NDT of FRP composites, select the approach that has the greatest potential of achieving the objective, and carry out a study to demonstrate the feasibility of the selected method.

8.16 NIST TOPIC: MEASUREMENT AND STANDARDS FOR MEMBRANE MATERIALS

8.16.1T Subtopic: Application of Radionuclides to Nanoscale Porosity Characterization

Filters and membranes with extremely small pore sizes (tens or hundreds of Angstroms) have been used extensively in biomedical and physical fields of research and have potential use in a variety of applications including high selectivity in the separation and purification of waste water and air. In biomedicine, filters of various materials are utilized during purification and concentration steps through such diverse applications as particulate removal, dialysis and degassing. In tribology and material sciences, membranes have found a vital role in both liquid and gas phase filtration. In fact, potential applications of particularly small pored membranes (smaller than ten Angstroms) would have direct use in the studies of finite size effects and catalysis. Pore sizes of five to 10 Angstroms would be useful in gas filtrations where diatomic gas molecules (between 0.75 and 5.5 Angstroms in diameter) need to be filtered from molecular clusters of greater diameter. Additional applications would arise once suitable methods for porosity characterization are developed. Unfortunately, at this time, the determination and standardization of very small pore diameters is limited by a lack of appropriate tracers.

The sizes of the radioactive molecules must be accurately measured through possible experimental techniques such as High Resolution Transmission Electron Microscopy (HRTEM), Scanning Tunneling Microscopy (STM) and neutron diffraction. Tracing radiolabelled molecules with various detection systems (phosphor plate imaging, MultiPhoton Detection, autoradiography, etc.) as they flow across a porous membrane would allow characterization of pore sizes in the molecular range to an accuracy of tenths of angstroms by determining the maximum sized molecules that will successfully pass through the membrane. It is possible to simultaneously introduce several different sized molecules into a porous system if they are doped with isotopes of different emission character yielding a "multicolored" system. The use of several radioisotopes emitting different energies or having different half-lives linked to molecules of various sizes would make a "multicolored" system where size-dependent transmission and blockage could be observed simultaneously. The successful production and subsequent application of such multicolored radioactive molecules to membrane studies would constitute a significant advance in the field of porosity characterization.

This work complements the Physics Lab research programs involving several aspects of nuclear medicine, including investigations of novel delivery and purification methods of radiopharmaceuticals on the nanoscale level. Research at NIST has focused on the production, purification and standardization of various radioactive isotopes with direct applications in nuclear medicine on a macroscale level. This research will lead to alternate purification systems, to be used *in vitro* and *in vivo*, of various radioisotopes used in medical imaging, diagnosis, and, potentially, cancer treatment.

8.17 NIST TOPIC: MICROELECTRONICS MANUFACTURING INFRASTRUCTURE

8.17.1T Subtopic: Scanning Microwave Microscope for 2-D and 3-D Dopant Profiling of Semiconductors

Dopant profiling of silicon in two- and three-dimensions (2- and 3-D) with a few nm spatial resolution and 10% accuracy over the dopant range of 10^{20} to 10^{15} cm^{-3} is a critical measurement need for next-generation integrated circuits. Two scanning probe microscope (SPM) methods have been developed to measure 2-D dopant profiles: scanning spreading resistance and the scanning capacitance microscope (SCM). Both techniques measure some aspect of the probe tip to semiconductor electrical impedance. Scanning spreading resistance measures dc resistance, while SCM measures capacitance with a resonant peak shift sensor at 915 MHZ. The impedance of the SPM tip to a semiconductor has not been extensively investigated at intermediate or higher frequencies.

NIST is seeking proposals to develop instruments which will integrate analysis of the tip-to-semiconductor impedance in *the low GHz* range with a scanning probe microscope. Desirable tools would be sensitive to variations in semiconductor dopant concentration, lifetime, surface states, dielectric constant, and/or buried layers of a multi-layer integrated circuit structure. Possible implementations of the tool may be a scanning microwave microscope capable of measuring the reflected and transmitted components of a variable frequency microwave signal

applied between an SPM tip and a semiconductor. A successful Phase 1 contract will require an investigation of the tip-to-sample impedance as a function of frequency, techniques to apply high frequency signals to a semiconductor with a nano-probe tip (such as micro-strip lines), determination of spatial resolution, and demonstration of the ability of the instrument to probe a semiconductor in depth (Z-direction) while scanning the tip in X and Y.

8.17.2T Subtopic: *In-Situ*, Closed-Loop Control of Semiconductor Epitaxial Deposition

A major challenge to the implementation of in-situ growth probes for semiconductor manufacturing is the development of technology to take the output of in-situ monitors and sensors to control important growth parameters in an active, real-time manner. An additional constraint on intelligent epitaxial control deals with the algorithms required to combine inputs from more than one sensor to control the same growth parameter.

The development of these technologies for this national critical technology will help ensure the growth capabilities required for next-generation optoelectronic and semiconductor applications. These commercial applications include the manufacturing of high speed hetero-bipolar transistors (HBTs) as well as psuedomorphic high electron mobility transistors (pHEMTs) for wireless applications in addition to lasers for optical transceivers. The content of the proposal should detail a technical strategy for developing a process that will take output from a particular growth parameter (e.g., temperature, composition, beam flux, lattice parameter) and use this output, in a closed loop fashion, to control a critical parameter of the deposition process. This parameter could be sample temperature, source flux, effusion cell temperature, or gas flow rates for MOCVD and/or MBE processes. The technical strategy should contain clear provisions for demonstrating the final structure quality with, and without, in-situ closed loop control.

References:

Roth, J.A., T.J. de Lyon, M.E. Adel, presented at Diagnostic Techniques for Semiconductor Materials Processing Symposium, Boston, MA, Nov. 29 – Dec. 2, 1995.

Johnson, S.R., C. Lavoie, T. Tiedje, and J.A. MacKenzie, J. Vac. Science and Technology, B11, 1007, 1993.

8.17.3T Subtopic: At-Speed Test of High-Speed Digital ICs

The at-speed test of waveforms in high speed digital ICs is currently a very difficult problem with no completely satisfactory technical solutions. While electron beam systems are capable of measuring the waveforms in operating digital circuits, these systems have limited measurement speed and are costly to construct and operate. NIST is soliciting proposals to develop systems for the at-speed test of high-speed digital ICs that overcome these limitations. Solutions may be based on atomic force microscopy, optical probing, contact probing, improvements of traditional electron-beam systems, or other technologies.

8.17.4T Subtopic: Materials and Device Technologies for Next Generation MMIC Devices for Wireless Applications

Microwave and millimeter wave integrated circuits (MMICs) are of increasing importance in wireless communication systems. Current trends are toward low cost, high density, multilevel and multifunctional integration. Research on testing and measurement techniques, as well as material and fabrication technologies, are being directed to meet these challenges.

This subtopic covers several areas of interest to MMIC device manufacturers: innovations to improve the quality of material supplies to Gallium Arsenide (GaAs) Fabs, as well as manufacturing challenges for hetero-bipolar transistors (HBTs) and psuedomorphic high electron mobility transistors (pHEMTs). Technologies to reduce turn-on voltages, improve power-added-efficiency, high linearity, and high output powers, are appropriate proposal topics. Because the turn on voltage is fundamentally limited by the base material energy bandgap for HBTs, proposals that deal with improving the epilayer quality through pre-growth, real time, and post growth methods are expected to make significant contributions.

Other areas include materials issues to improve the reliability of HBTs and pHEMTs and 3-D GaAs MMIC technology for high frequency applications.

References:

Das, N.K., and H.L. Bertoni, editors, "Directions for the Next Generation of MMIC Devices and Systems." Plenum Press, New York, 1997.

McQuiddy, D.N. et. al., "Monolithic Microwave Integrated Circuits: A Historical Perspective." IEEE Trans. Microwave Theory Tech., Special Centennial Issue, 32: 991, 1984.

8.17.5TSubtopic: Advanced Chemical Modeling and Simulation Tools for Semiconductor Processing

Advanced chemical modeling and simulation tools are needed for the study of semiconductor processing systems. Software presently exists for modeling different applications involving chemically reacting flows including those pertaining to semiconductor processing. However, there are two important aspects of currently available modeling software that are largely missing from the ideal toolbox. The first missing tool involves the ability to efficiently generate and manage chemical kinetic mechanisms, while the second missing tool involves the ability to efficiently analyze the results of reacting flow simulations. The first tool, a preprocessor for chemical kinetics simulations, would enable the modeler to quickly generate a chemical kinetic mechanism and select desired molecular species and chemical reactions along with necessary thermochemical, chemical kinetic, and physical property data. The second tool, a postprocessor for chemical kinetics simulations, would enable the modeler to rapidly sort through and view species and reaction information generated in the simulations. These interactive tools would greatly facilitate the development of a fundamental understanding of highly-coupled chemically

reacting systems in semiconductor processing by providing the ability to quickly probe the impact of variations in process parameters and proposed mechanisms. NIST has developed research prototypes of these tools that would need to be made robust, integrated into existing simulation software, and finally commercialized.

8.17.6T Subtopic: An Apparatus and Method to Determine Thermocouple Inhomogeneity

Thermocouples are extensively used in industry to measure temperature, but a thermocouple cannot be reliably recalibrated outside its usage environment unless its thermoelectric inhomogeneity is characterized. Various research apparatuses have been built to characterize thermocouple inhomogeneity, but there exists no apparatus or accepted method suitable for use in an industrial laboratory environment. Development of such an instrument would improve the accuracy of industrial thermocouple calibrations and assist laboratories in better determining when recalibration is necessary.

An apparatus to measure thermocouple inhomogeneity should impose a well-controlled temperature step at any position along the length of the thermocouple and record the variations of thermocouple output as a function of the position of this step. The magnitude of the temperature step should be variable between 100 ^{0}C and 400 ^{0}C, and the thermal gradient at the middle of the step should be as large as possible. Materials of construction should be chosen to minimize contamination of the tested thermocouples. For ease of use, the apparatus must be automated.

8.17.7T Subtopic: High Temperature Thin-film Insulation

High temperature (900 °C) thermometry and heat-flux gages require high temperature thin-film insulators. The gages may employ noble metal thermoelements such as platinum, palladium, and rhodium alloys or heat resistant nickel alloys. Although some success has been obtained using sputtered oxide coatings, several problems interfere with commercial applications. Commercial insulators are limited by low melting substrates, such as anodized aluminum; high cost sputtered oxide techniques; and pinholes and flaws in CVD and sputtered coatings. The ideal coating would be less than four micrometers thick; defect free with a high dielectric breakdown voltage; inexpensive to deposit on a variety of metal substrates of various shapes; well bounded to the substrate and the thin-film conductors above; and stable in the environment of the application.

Proposals are sought for innovative methods to achieve the fabrication of low-cost, high-temperature thin-film insulators. These insulators should be capable of electrically insulating thin-film sensors from metallic substrates at temperatures ranging up to 1100 °C with a thickness of less than four micrometers. The thin-film insulator should be compatible with stainless steels, high-temperature nickel-based alloys, and noble metals such as platinum and palladium. Application in the temperature range of 500-800 °C are also important and will be considered. The planned project should demonstrate the fabrication of the thin-film insulator on suitable substrates, including silicon, for thermocouples and heat transfer gages, and also demonstrate the

performance of the insulating film. A plan for commercialization of the process is also important.

The following NIST Patents may be related to this subtopic:

NIST #88-033, U.S. Patent #4,969,956 “Transparent Thin Film Thermocouple”

NIST #91-010, U.S. Patent #5,251,981 “Corrosion Resistant Thin Film Thermocouples and Methods”

NIST #92-001, U.S. Patent #5,356,485 “Intermetallic Thermocouples”

NIST #93-053, U.S. Patent #5,474, 619 “Thin Film High Temperature Silicide Thermocouples”

NIST #97-021, U.S. Patent Pending “Temperature Calibration Wafer For Rapid Thermal Processing Using Thin-Film Thermocouples”

8.17.8T Subtopic: Measurement of Trace Alpha-Radiation in Polymeric Microchip Material

Electrical breakdowns in microchips have been observed for over 10 years. Alpha particle emissions from materials used in the assembly and packaging were determined as the sources that triggered many of these effects. The problem is even more critical in the latest, denser generation of microchips which incorporate polymeric materials into the chip itself. The Semiconductor Industry Association in its 1997 National Technology Roadmap for Semiconductors has expressed that a measurement of the trace radioactivity in this type of materials is a prerequisite to the improving of wafer bumping and the development of new flip chip technologies. This program will be a part of the NIST wide effort to meet the highest priority measurement needs of the semiconductor industry.

Estimates by the polymer manufacturer of the degree of contamination have been questioned by the microchip manufacturer. A reliable methodology is needed to provide certified measurements of this type of materials for alpha-particles emitted per unit volume per day. Proposals are being sought to develop an innovative and cost-effective technology capable of measuring alpha activities at or below the environmental level. The potential impact of a solution to this problem could be very large commercially and would provide a means to test procedures that would greatly improve the quality and reliability of microchips.

8.17.9T Subtopic: Advanced Ion Beam Methods for Nanotechnology

Ion beams are used in various subdisciplines of nanotechnology, including: microelectronics (implantation, lithography, mask repair, failure diagnostics, etc.), biotechnology (production of nano-scale pores for drug delivery, biosensors, etc.) and photonics (production of flat panel displays, diode lasers, optical waveguides, etc). NIST is seeking proposals for innovative ways

to produce and apply ion beams for use in the general area of nanotechnology. Work should be geared towards new methods rather than incremental improvements in established techniques. Proposed research should contain a component which considers how increasing the ion charge to very high values would modify the results.

References:

Sealy, B.J., P.L.F. Hemment, "Ion beam techniques in microelectronics." Nucl. Instrum. Meth. Phys. Res. B, 89, 298, 1994.

Reber, N., et al, "Thermal Switching of grafted single ion tracks." Nucl. Instrum. Meth. Phys. Res. B, 105, 275, 1995.

Polman, A., et al., "Ion beam synthesis of planar opto-electronic devices." Nucl. Instrum. Meth. Phys. Res. B, 106, 393, 1995.

Cheng, H.P., J.D. Gillaspy, "Nanoscale modification of silicon surfaces via Coulomb explosion." Phys. Rev. B, 55, 2628, 1997.

8.17.10T Subtopic: High Precision Manufacturing of Rockwell Diamond Indenters

Indentation hardness tests, such as the Rockwell test, are the most common methods used to rapidly evaluate the strength of metals and ceramics. The principle of indentation hardness testing is to force an indenter, usually diamond tipped, into the part to be tested and to measure the size or depth of the indentation that is produced. The geometric shape of the diamond indenter is specified in ASTM and ISO hardness standard test methods. However, the precise shape of the diamond indenter significantly affects the measured hardness value. Small variations in the geometry of one indenter compared with another indenter can produce variations in the measured hardness values that are as large as the tolerances in specification for the materials that is being evaluated.

At present, the final geometry of the diamond indenters is produced by grinding and polishing the rough cut diamond with fine diamond powder. Because the diamond to be formed is as hard as the diamond polishing compound and because of the crystallographic features of the diamond, it is neither possible to produce exactly the correct geometry nor to produce any specific geometry repeatedly. The result is an unacceptably large variation in the microform geometry of the available indenters and therefore in the measured hardness values.

The U.S. is currently developing national hardness reference standards for Rockwell hardness tests that are traceable to NIST. To provide this traceability with acceptable limits on the uncertainty of the hardness measurements, a reliable supply of diamond indenters that are more geometrically correct than those presently available is required. The Rockwell diamond indenter is a diamond cone with 120° cone angle blending smoothly into a spherical tip of 200 μm radius. It is believed that novel methods of producing the microform shape of the diamond indenters,

such as electrochemical polishing and forming, chemomechanical forming, or significantly improved polishing and grinding procedures must be developed to meet the increasingly strict requirements of diamond indenters used to make accurate and traceable measurements.

8.18 NIST TOPIC: MICROFABRICATION AND MICROMACHINING

8.18.1T Subtopic: Ultra-Sensitive Atomic Force Microscope Cantilevers

NIST has recently established the Nanoprobe Imaging for Magnetic Technology Project. The primary goal of the project is to develop scanned probe microscopy (SPM) instrumentation that has promising industrial applications. For example, SPM techniques such as magnetic force microscopy, magnetic resonance force microscopy, lateral (friction) force microscopy, and scanning potentiometry are considered as useful or potentially useful industrial tools. These imaging techniques rely on precise measurements of electrodynamic forces between the AFM cantilever tip and the sample.

Typical force detection limits of commercially available AFM instruments under ambient conditions (room-temperature, in-air) are in the 10^{-10} to 10^{-13} N/ Hz range. Sensitivities as low as 10^{-16} N/ Hz have been demonstrated in vacuum (minimizing air damping) with ultra-sensitive micromachined silicon nitride cantilevers. NIST is soliciting proposals for developing a batch fabrication process for ultra-sensitive AFM cantilevers. The cantilevers will be used to study extremely small electro-dynamic forces such as the interaction between an MFM tip and a single NMR spin. The batch fabrication process should have high yield, high conformity between cantilevers within a wafer, and high repeatability. A demonstrated AFM instrument sensitivity of better than 10^{-16} N/ Hz at room temperature (preferably in air) will be required. Finally, proposals should address the issues of incorporating the cantilevers into existing or future commercial AFM instruments.

8.18.2T Subtopic: Six-degree-of-freedom Positioning Stage

NIST is currently evaluating a new generation of force sensors for nanometer-scale distance control for use in scanned probe microscopy (SPM). The sensor concept is based on a microfabricated quartz oscillator and possesses a number of potential advantages for fundamental metrology and industrial applications of SPMs. Because these sensors are self-contained, low-mass, low-profile structures with high resonant frequencies, we expect dramatic improvements in the quality of dimensional nanometer-scale measurements. This may be accomplished by embedding the new generation of SPMs into a more extensive array of measurement tools than is now feasible with current force-sensing technology. Recently, we have demonstrated a low-cost, manufacturable approach for assembling ultrasharp, microfabricated silicon probe tips onto the quartz sensor, enabling this sensor to now serve as a general-purpose SPM platform. In order to characterize completely the errors that arise from the inherently three-dimensional interaction between the finite size of the probe tip and calibration features, we intend to implement six degree-of-freedom (6-DOF) control of the sensor assembly with tip-sample alignment via optical and scanning electron microscopies.

NIST is soliciting proposals which will demonstrate the potential to perform 6-DOF position control of a low-mass (ca. 100-200 gm), low-profile (ca. 3-5 cm height) sensor assembly in ambient and low-vacuum conditions. The Phase 1 deliverable will be a functional prototype embodying a meaningful subset of a fully operational Phase 2 positioning stage. Proposals responding to this solicitation must include an outline of the development path leading from Phase 1 to Phase 2.

8.18.3T Subtopic: MEMS Atomizer for Generation of Uniform Droplet Size Distribution in Aerosols

Microelectromechanical systems (MEMS) technology is being used to develop microatomizers for a wide range of industrial applications. Of special interest is the use of these atomizers as a reference device for calibration of particle sizing instrumentation. Although MEMS atomizers are designed to provide a uniform array of droplets, attempts to validate the actual uniformity of the droplets when operated as a well-dispersed spray has generally met with poor results. A MEMS atomizer is sought that will provide a well-behaved spray and operate in high-temperature environments. Droplet uniformity in both size (tunable over the range of 0.5 μm to 50 μm) distribution and spatial dispersion must be demonstrated while using a variety of fuels that include multiphase and multicomponent mixtures. The design should also be amenable ultimately to generate well-behaved sprays in which one may form nonuniform size distributions (including bimodal distributions). Number density should be high enough ($>10^4$ particles/cm^3) to be representative of an actual spray.

Phase 1 should demonstrate the feasibility of the MEMS device to meet the stated criteria. The objective of Phase 2 is the delivery of a functioning MEMS atomizer. It is expected that this new measurement capability will find immediate commercial applications for a wide range of nonreacting and reacting spray technologies.

8.18.4T Subtopic: Miniaturized Detectors for Brachytherapy Dosimetry

Dosimetry measurements on brachytherapy sources in tissue-equivalent media are very difficult to make accurately because of the very high dose-rate gradients in the vicinity of the sources. Conventional detectors in use today include small-volume ionization chambers, thermoluminescence dosimeters (TLDs), solid state devices (diodes and diamond detectors), plastic scintillators, and radiation-sensitive films. Current technology limits on detector sizes are on the order of 0.5 to 1 mm, usually in one dimension only. Thinner materials must be supported on thicker, often non-tissue equivalent substrates. Sensitivity is usually attained only at the expense of added volume in the other two detector dimensions, compromising resolution in these dimensions. Requirements for new detectors include sizes of 0.5 mm or less in all three dimensions, the ability to operate under water, tissue equivalence in their radiation absorption and scattering properties for electrons from 100 keV to 4 MeV and photons from 10 keV to 1 MeV, and sensitivity sufficient to detect clearly an absorbed dose rate of 1 mGy/s, or, for passive devices, absorbed doses of 1 mGy.

References:

Chiu-Tsao, S.T., L.L. Anderson, "Thermoluminescent Dosimetry for 103Pd (Model 200) in Solid Water Phantom." Med. Phys. 18, 449-452, 1991.

Fluehs, D., M. Heintz, F. Indenkampen, C. Wieczorek, H. Kolanski and U. Quast, "Direct Reading Measurement of Absorbed Dose with Plastic Scintillators – The General Concept and Applications to Ophthalmic Plaque Dosimetry." Med. Phys. 23, 427-434, 1996.

Soares, C.G., D.G. Halpern, C.-K. Wang, "Calibration and Characterization of Beta-particle Sources for Intravascular Brachytherapy." Med. Phys. 25, 339-346, 1998.

8.18.5T Subtopic: Three-Dimensional Imaging System for Low Activity Brachytherapy Sources

Uniformity of the radioactivity contained in very small sources used in brachytherapy has become an important issue with the advent of intravascular brachytherapy where single sources are used to deliver absorbed dose to tissues very close to the source. Conventional methods used to do such dosimetry mapping are generally limited to the use of radiochromic film, which has a rather low sensitivity, requiring absorbed doses on the order of at least a few Gy for a detectable image. This dose level is too low for an important class of brachytherapy sources which contain generally 1 mCi or less of radioactive material. Thus alternative methods are required for the dosimetry and dose uniformity measurement of such low-activity sources. The required imaging system must have a spatial resolution of at least 0.1 mm, and have sensitivity sufficient to detect clearly an absorbed dose rate of 1 mGy/s, or, for passive devices, absorbed doses of 1 mGy or less.

References:

Miyahara, J., "The Imaging Plate: A New Radiation Image Sensor." Chemistry Today, 29-36, October 1989.

Soares, C.G., D.G. Halpern and C.-K. Wang, "Calibration and Characterization of Beta-particle Sources for Intravascular Brachytherapy." Med. Phys. 25, 339-346, 1998.

8.18.6T Subtopic: Microfabricated Cantilever Probes for Combined near-field Scanning Optical and Atomic Force Microscopy

Near field scanning optical microscopy (NSOM) is rapidly becoming a useful technique for nanoscale optical characterization of materials. NSOM makes use of the properties of a sub-wavelength optical probe to exceed the diffraction limit in optical microscopy. Images are constructed by scanning the probe over a surface at distances much smaller than a wavelength of light. Contrast is generated by way of a number of different interactions of the sample and

probe, including such traditional optical contrast mechanisms as absorption, reflection, fluorescence, and polarization, and also new contrast mechanisms that are unique to NSOM, including dielectric contrast. Probes currently in use for this purpose include single mode glass optical fibers drawn to a fine point (about 50 nm) and usually partially coated with aluminum, and small metallic scatterers.

NIST is seeking microfabricated aperture, waveguide, or combination aperture/scatterer NSOM probes in a form that is compatible with atomic force microscopy (AFM). These probes should be useable as contact, noncontact, or intermittent contact probes in commercially available atomic force microscopes, but should have the additional feature of a small subwavelength aperture or tapered waveguide structure for guiding and confining light. Waveguide or aperture probes with a small scatterer at the tip will also be considered.

Newer data storage devices are exploring the concept of recording more than one bit of information per physical location on the media. For example, one project funded by ATP relies on a variable-depth pit in a substrate to encode information in a very dense array of spots similar to those on a CD-ROM. The cantilever proves for combined near-field scanning optical and atomic force microscopy may lead to a powerful combination of measurement and diagnostic tools that will have market applications in the data storage industry.

8.18.7T Subtopic: Standard Reference Materials and Resolution Test Patterns for Characterization of Scanning near-field Optical Microscopes

Near field scanning optical microscopy (NSOM) is rapidly becoming a useful technique for nanoscale optical characterization of materials. NSOM makes use of the properties of a sub-wavelength optical probe to exceed the diffraction limit in optical microscopy. Images are constructed by scanning the probe over a surface at distances much smaller than a wavelength of light. Contrast is generated by way of a number of different interactions of the sample and probe, including such traditional optical contrast mechanisms as absorption, reflection, fluorescence and polarization, and also new contrast mechanisms that are unique to NSOM, including dielectric contrast. Because of these optical contrast mechanisms, NSOM could have significant applications in metrology for magnetic and optical data storage materials, particularly in cases where STM or AFM contrast mechanisms may not be applicable.

NSOM probes currently in use include single mode glass optical fibers drawn to a fine point (about 50 nm) and usually partially coated with aluminum, and small metallic scatterers. Probes can be used either for collection of light or for illumination of the sample. Resolution in NSOM depends on the size and efficiency of the probes, and is intimately tied to the contrast mechanism used. No standard techniques or materials exist for determining the resolution and characterizing the contrast mechanism of these probes.

NIST is seeking proposals for development of suitable reference materials and resolution test patterns to determine the resolution, and characterize the contrast mechanisms of near-field probes. Suitable materials will have nanoscale optical features that have little or no topography,

and will be useful for characterizing probes used in reflection, absorption, polarization, fluorescence, or dielectric contrast.

8.19 NIST TOPIC: ORGANIC ELECTRONIC MATERIALS TECHNOLOGY

8.19.1T Subtopic: Organic Electronic Materials and Device Manufacturing

This subtopic aims to stimulate R&D needed for enhanced insertion of organic electronic materials (OEM) technologies in the manufacture of future commercial electronic or photonic products. Competitive microelectronics manufacturing depends upon the availability of innovative and cost-effective materials manufacturing technology which can be integrated within the diverse electronics sub-systems that constitute tomorrow's electronics products. Whether it is for memory or logic devices, information displays, light or power sources, detectors, interconnections, sub-system packaging or image patterning, OEM technology is a key enabler for the function of current and future electronic products. Historically, small businesses have been an important source of innovation in OEM technologies.

Organic electronic materials are polymeric and small-molecule compounds that are designed to either maximize their interaction with electromagnetic fields (such as electrical or optical), or behave as "stealth-like," transparent media such that field and material perturbations are minimized. They may be used to create bulk, micrometer-scale dimension structures, or used as ultra-thin films (such as structured multilayers), sometimes approaching hundreds of Angstroms in thickness. Due to their often complex physical behaviors and the need to control their characteristics at micrometer and below dimensions over very large relative or absolute areas, OEMs often exist as high-value, limited-volume compositions that challenge today's materials development, manufacture, processing, and utilization technologies. Commercial organic electronics technology solutions must be cost-effectively integratable within today's manufacturing environment if user industries are to utilize these options. Hence manufacturability is a key criteria for success. These factors, in addition to the need for OEMs to meet product-lifetime requirements under sometimes harsh or extended conditions, constitute some of the major technological issues that limit current market reliance on this technology. Proposals are solicited for R&D that advances the performance and fabrication of organic electronic materials and their devices at reduced cost, or that addresses barriers that inhibit the integration of OEM technology within an expanded portion of new electronics products.

8.20 NIST TOPIC: PHOTONICS MANUFACTURING

8.20.1T Subtopic: Photonic Components/Systems Manufacturing Cost Reduction

To compete internationally in the production of high volume products, U.S. photonics companies must continue to reduce costs. To compete with commercial products, where cost is at least as important a factor as performance, the U.S. must strive for efficient manufacturing. The objective of this subtopic is to foster technologies which decrease manufacturing process times, reduce costs, and/or greatly improve the yield for photonics devices.

Proposals are solicited that target technologies for the manufacture of photonics components and systems -- better materials, processing methods, equipment, instrumentation, packaging technologies, simulation and modeling tools. For example, in a wide range of photonics components, 60 to 80% of the cost of manufacturing is in the assembly and packaging. Changing this situation is an essential step in reducing manufacturing costs. The availability of improved tools for simulation, modeling, and computer-aided design (CAD) will greatly reduce manufacturing expense by reducing the design, build, and test cycle. Many of the key devices used in photonics systems -- diode lasers, light emitting diodes (LEDs), detectors, and some types of amplifiers and modulators-- are manufactured from compound semiconductors, e.g. GaAs, AlGaAs, InP, etc. To improve the efficacy of the U.S. industry, improvements are required in the management and control of the material processes, e.g., in the epitaxial growth of heterostructures, in the purity of starting materials, and in the reliability of domestically produced substrate materials. Photonics is an area where many innovative contributions have come from the small business community and they are encouraged to participate in this solicitation.

8.20.2T Subtopic: *In situ* Resistivity Measurements during Epitaxial Growth of Semiconductors

Although a number of properties of epitaxial semiconductor films can be measured *in situ*, resistivity or doping level is still determined by post-growth characterization. The use of *ex situ* characterization mandates expensive calibration runs, limits flexibility in changing device design parameters, and generally requires destructive testing for samples with more than one layer. We are requesting proposals to demonstrate techniques for the measurement of carrier concentrations in the range of 10^{16} to 10^{19} cm^{-3} in semiconductor films as they are being grown. The techniques should be compatible with use in molecular beam epitaxy (MBE) and/or organometallic vapor phase epitaxy (OMVPE). In keeping with industrial needs for device manufacture, at least 20% accuracy and 10% precision should be achievable in principle. Phase 1 research should provide a proof-of-concept for the measurement technique and data analysis. Phase 2 work is expected to include demonstration of the measurement technique during growth of films with different doping levels covering the above range.

8.20.3T Subtopic: High Speed Normalization for Optical Sensors

NIST has developed passive probes that use optical-fiber link and electro-optic modulators to measure rf electromagnetic fields. The signal levels from such probes are dependent on the intensity of the optical carrier. To achieve good signal-to-noise ratio it is conventional to use balanced detection together with electro-optic modulators that have complementary outputs. However, if the photodetector output is normalized by the sum of the channel intensities, significant improvement in the signal to noise ratio and the signal stability can be achieved, especially in cases where the laser power is undergoing fluctuations because of a necessity to change its wavelength during the measurement process.

NIST is soliciting proposals for innovative electrical or optoelectronic circuitry that will provide a high bandwidth, analog divide function for our sensor applications. The frequency response

should extend from DC to 1 GHz with a possibility for extending it to 10 GHz. Presently available log-antilog amplifier combinations do not have the required wide bandwidth. The input could be either the electrical signal from photodiodes or, more directly, the combined optical intensities from the complementary outputs of the modulator. The dynamic range should cover at least 10 dB optical or 20 dB electrical, with a preference for twice these values. If use of an optical input is proposed, we will give preference to a system using optical wavelength around 1300 nm, but other wavelengths such as 850 nm or 1550 nm would also be considered.

A circuit module or integrated circuit which performs the required divide function would have applications over the broad range of photonic sensor technology.

Reference:

Masterson, Keith D., David R. Novotny, and Kenneth H. Cavcey, "Standard Antennas Designed with Electrooptic Modulators and Optical-fiber Linkage." Intense Microwave Pulses, IV, H. Brandt. ed. SPIE 2831, pp.188-196, Oct. 1996.

8.20.4T Subtopic: *In Situ*, Noncontact Temperature Measurements of Semiconductors

Accurate temperature control during semiconductor processing is important for process reproducibility. During epitaxial growth of compound semiconductors by molecular beam epitaxy (MBE), the substrate temperature is usually measured with a single wavelength pyrometer. However, the lowest accurate temperature for most pyrometers is 450 °C. This is not sufficient for several emerging semiconductors that require substrate temperatures between 150 °C and 450 °C. We are requesting proposals that demonstrate noncontact techniques that can accurately measure the temperature of a semiconductor wafer that is inside a vacuum chamber. The preferred technique should be capable of measuring temperature from 150 °C to 1000 °C. Preference will be given to proposals in which Phase 2 work will include delivery of a protoype measurement system to NIST.

8.20.5T Subtopic: Agile Wavelength Tuning for Diode Lasers

NIST has developed probes which use optical-fiber links and electrooptic transducers to measure rf and microwave electromagnetic fields. Such probes require a means for stabilizing their output against other environmental changes such as temperature changes and acoustic vibrations. One way to accomplish this could be by rapidly tuning the wavelength of the diode source laser over a 1 to 2 nm wavelength range in a few microseconds. Presently available tunable diode laser systems are unable to meet this demand.

NIST is soliciting proposals to develop diode lasers and/or tuning systems that will meet this requirement. A couple possible technologies for realizing an appropriate tuning system might be electro-optics or surface acoustic waves, but any technology which meets the requirements would be considered. The system should simultaneously produce a narrow spectral line with a width of

less than 10 MHZ and the capability of eventually getting below 1 MHZ. Since such a tuning system would have applications in many other optical-fiber based sensor systems, there would be a substantial commercial market. In addition, with only slight improvements it could be used in wavelength multiplexed telecommunication systems where a very large commercial market is expected to develop in the near future.

Reference:

Masterson, Keith D., David R. Novotny, and Kenneth H. Cavcey, "Standard Antennas Designed with Electrooptic Modulators and Optical-fiber Linkage." Intense Microwave Pulses, IV, H. Brandt. ed. SPIE 2831, pp.188-196, Oct. 1996.

8.20.6T Subtopic: Ultra-hard/sapphire Tools for Precision Machining

Over the last two decades, technology has developed for ultra-precision machining of optical quality surfaces using single crystal diamonds as the tool material. Single crystal tools provide better finish because better quality edges can be made and maintained. While diamond is the hardest available material, it has limitations in use arising from chemical interactions between tool and work material (see for example Paul E., Evans C. J., Mangiamelli A., McGlauflin M. L., and Polvani R. S.) "Chemical aspects of diamond tool wear" Precision Engineering, 18(1996) 1, pp4-19). Some efforts have been made – but with reportedly little success to grow large enough high quality cubic boron nitride crystals to make tools.

NIST has two requirements for tools of a quality similar to single crystal diamond tools but for applications that cannot be met using single crystal diamond tools. First NIST needs to precision machine artifacts – for example prototype mass standards -- from high purity metals that cause rapid chemical wear of diamonds (e.g., tungsten and niobium). The second need is to develop in-situ, possibly through the tool, methods for the measurement of conditions in the tool work-piece interface. Both needs might be met using sapphire tools. The first need may be met using one of the new nanocrytalline ceramics – most likely silicon nitride or silicon carbide.

The innovative research required is the development of fabrication methods to generate accurate nose radius tools with edges of sharpness comparable to good diamond tools (see, for example, Lucca D. A. and Seo Y. W. "Effect of tool edge geometry on energy dissipation in ultra-precision machining" CIRP Annals, 42 (1993) Part 1, pp83-86). Such tools will only be produced if both surface finish and sub-surface damage are extremely good. Hence the developed fabrication methods may be applicable to substrates for semiconductor, opto-electronic and other applications.

8.20.7T Subtopic: Innovative Technology for the Measurement of Small Holes

There is an industry-wide need for innovative technology for measuring the dimensions and geometry of small holes -- with inside diameters of 1 mm to 2 mm or less. This need cannot

currently be met by NIST calibration services due to technology limitations. The highest accuracy need is for the measurement of high aspect ratio (length/diameter) microwave wave guide standards that have inside diameters of 1 mm or less and lengths up to 75 mm. Microwave standards are metallic in composition and have excellent surface finish. Low aspect ratio holes of interest include wire dies, fiber optics connectors, fuel injectors, and precision pinholes each of which have diameters in the mm to micrometer range. Current optical methods are limited by the uncertainty in edge location that results from diffraction, and contact methods are limited by the size and stiffness of most contact probe mechanisms. It is unlikely that any single technique will be applicable to the measurement of all small hole, so proposals advancing the development of innovative technology for any subclass of small hole measurement will be considered. The proposal may address stand-alone technology, or technology to be integrated with existing coordinate measurement systems.

8.20.8T Subtopic: Diode Lasers for Advanced Atomic Clocks

Over the last 15 years, scientists have developed concepts for using lasers to cool atoms and ions, to put atoms and ions into particular atomic states and then to determine which states they are in at a later time. These ideas have been the basis for the development of a wide range of new atomic clocks, which depend on reliable lasers with modestly demanding characteristics. Because they are small, inexpensive and efficient, diode lasers are the devices of choice, but it is difficult to obtain diode lasers with the required specifications at the critical wavelengths (852 nm for the cesium atom and 780 nm for the rubidium atom). The objective in this subtopic is to develop high-power (300-700 mW) and low-power (1-5 mW) diode lasers operating with single spectral mode and single spatial mode at 852 nm or 780 nm. We require linewidths less than 1 MHZ for the high-power lasers and less than 10 MHZ for the low-power lasers. The more important wavelength for NIST's work is 852 nm (cesium atom), since this is what is needed to produce primary frequency standards. The more immediate need is for the high-power lasers used for trapping and cooling of atoms. While the development of these lasers will be useful to NIST programs, it is also important to note that work is starting on commercial versions of some of these advanced atomic clocks, and these will also need reliable diode lasers. Finally, there are other atomic-physics applications (involving other atoms) for diode lasers operating in these wavelength regions.

References:

Wieman, C. and L. Hollberg,"Using diode lasers for atomic physics," Rev. Sci. Instrum., **62**, 1-20, 1991.

Itano, W.M., and N.F. Ramsey, "The accurate measurement of time," Sci. Am., **269**, 56-65, 1993.

8.21 NIST TOPIC: SUPPORTING TECHNOLOGIES FOR SEMICONDUCTOR LITHOGRAPHY

8.21.1T Subtopic: Deep Ultraviolet Transfer Standards for Excimer Laser Photolithography

NIST has developed a set of primary standard laser calorimeters for KrF excimer laser energy measurements and offers laser power and energy calibration services at a laser wavelength of 248 nm based on these standards. Primary standard laser calorimeters at 193 nm, for use with ArF excimer laser measurements, are currently under construction. In order to meet the demands of the semiconductor community for improved overall accuracy in the photolithographic process, NIST is developing improved transfer standards for deep ultraviolet (DUV) excimer laser energy and dose (energy density) measurements. At this time, the overall uncertainty for laser dose measurements at the wafer plane of a typical photolithographic tool is 5%. In order to improve throughput and process latitude, semiconductor manufacturers require an overall uncertainty of less than 1%. This goal is not achievable without improved transfer standards.

Ideal transfer standard characteristics include large dynamic range, linearity for continuous and pulsed radiation, uniform angular and spatial response, and long-term stability of response with extended DUV exposure. Presently, pyroelectric and solid-state detectors are used as DUV transfer standards. While pyroelectric detectors have good long-term stability, they generally suffer from low dynamic range and poor spatial uniformity. Typically solid-state detectors, such as silicon photodiodes, have good dynamic range. However, they suffer from inferior angular response, poor long-term stability with DUV exposure, and cannot provide a direct measurement of excimer laser power or energy without attenuation. Proposals are sought for the development of standards quality DUV detectors that satisfy all of the above requirements.

8.22 NIST TOPIC: INTEGRATION OF MANUFACTURING APPLICATIONS

8.22.1T Subtopic: Next Generation Process Exchange Tools and Applications

As manufacturing companies move toward increased integration, there is a growing need to share process information in addition to product data. Software applications range from those that simply portray processes graphically to tools that enable simulation, planning, analysis, scheduling, and/or control of processes. In collaboration with industry and academia, NIST is developing a Process Specification Language (PSL) that will be common to all manufacturing applications, generic enough to be decoupled from any given application, and robust enough to be able to represent the necessary process information for any given application. Additionally, the PSL will be sufficiently well defined to enable exchange of process information among established applications.

NIST is requesting proposals for computer-based tools to facilitate the use of the PSL for process modeling and process information exchange. Proposals should target the specification and design of generic PSL-based development and integration tools or extensions to manufacturing

application software. Solutions could involve the development of translators or wrappers for exchange, or tools for creating and editing PSL presentations.

References:

Internet site: http://www.nist.gov/psl/

Schlenoff, C., Knutilla, A., Ray S., “Unified Process Specification Language: Requirements for Modeling Process.” NISTIR 5910, National Institute of Standards and Technology, Gaithersburg, MD, 1996.

Knutilla, A., Schlenoff, C., Ray, S., “Process Specification Language: Analysis of Process Representations.” NISTIR 6160, National Institute of Standards and Technology, Gaithersburg, MD, 1998.

8.22.2T Subtopic: Automated Mediation of Ontological Perspectives

Collaborative efforts of a collection of individual stakeholders (e.g., engineering design) involves the manifestation and reconciliation of the individual "world views" of the stakeholders and the forging of a shared "world view" that facilitates and mediates their interaction. Both the individual and shared world views are comprised of an ontology of concepts that includes purposes/goals, assumptions, requirements, processes, products, resources, and decisions; furthermore, world views evolve, change, and grow throughout the duration of the effort. The ability of the stakeholders to interacting quickly and effectively is dependent on how quickly and thoroughly conflicts in "world views" can be detected and resolved.

Current efforts to establish a shared "world view" needed for collaborative efforts focus on the development and specification of ontologies, i.e., an enumeration of meaning-bearing symbols within a bounded context that may be used for representation and communication of information. These ontologies constitute a shared language for communication and are often represented with data models. The problem with searching for and constructing such a shared ontology assumes that an objective ontology exists and that it is knowable apart from those who construct and use the ontology. The theory of social construction challenges this assumption by asserting that meaning is created within a social context through the interaction of actors. The "best" ontology for one social group, therefore, would not necessarily be the "best" for another.

The Manufacturing Engineering Laboratory is soliciting proposals for development of tools and techniques needed to facilitate the interpretation and reconciliation of individual stakeholder perspectives and resulting in socially-constructed shared world view.

The result of this effort will be to:

1. establish a methodology for the capture of a stakeholder perspective (i.e., world view);

2. develop algorithms for the evolution of shared world view in response to changes of individual world views; and, if the project is funded for a second phase;

3. develop a prototype system to capture individual stakeholder perspectives and globally reconcile those perspectives through a shared, mediated perspective.

References:

Krogstie, J., Lindland, O.I., and Sindre, G. "Defining Quality Aspects for Conceptual Models." Proceedings of the IFIP8.1 Working Conference on Information Systems Concepts (ISCO3): Towards a Consolidation of Views, Marburg, Germany, 1995.

Krogstie, J., Lindland, O.I., and Sindre, T. "Towards a Deeper Understanding of Quality in Requirements Engineering." Proceedings of the 7th International Conference on Advanced Information Systems Engineering (CAiSE'95) Springer-Verlag. 82-95, Jyvaskyla, Finland, 1995.

Lindland, O.I., Sindre, G., and Solvberg, A., "Understanding Quality in Conceptual Modeling." IEEE Software, pp. 42-49, 1994.

Moody, D. and Shanks, G., "What Makes a Data Model Good? Evaluating the Quality of Entity Relationship Models." Proceedings of the Thirteenth International Entity Relationship Conference, Manchester, England, 1994.

Pohl, K., "The Three Dimensions of Requirements Engineering: A Framework and Its Applications." Information Systems, 19, 3, pp. 243-258, 1994.

Wiederhold , G. "Interoperation, Mediation, and Ontologies." Proceedings of the International Symposium on Fifth Generation Computer Systems (FGCS94), Workshop on Heterogeneous Cooperative Knowledge-Bases, pp 33-48, Tokyo, 1994.

West, M., ed., "Developing High Quality Data Models, Volume 2: The Generic Entity Framework, The Data Management Guide." Vol. 2., Shell International Petroleum Company Limited, London, 1994.

8.22.3T Subtopic: Developmental and Operational Evaluation of Conceptual Model Quality

Exchanging data between computer systems is a solved problem. The combination of ASCII data files, TCP/IP, and the collection of interconnected cables called the Internet permitted files

to be exchanged between computers all over the world. This "first wave" of system interoperability was primarily syntactic and file-based. HTML brought data exchange to a new level by allowing visual presentation information/instructions to be exchanged and used by receiving (client) applications to format and display the data to a human viewer. This "second wave" was oriented to conveyance of visual information, so that system interoperability was visually based and relied on human interpretation. The third wave of intersystem interoperability is the exchange of semantic objects that are meaningful not only to humans, but to automated agents as well.

These semantic objects can be documented and promulgated using a number of different languages: data modeling language, knowledge representation languages, object modeling languages, XML DTDs. The models written in these languages are called ontologies, and they represent the terminology, relationships and constraints between concepts within some domain (the model of an ontology is called a "conceptual model"). The flurry of activity with respect to ontologies, KR, objects, and XML attests to the intensity of interest in the field.

The problem is that there is no way to evaluate the quality of ontologies (conceptual models). The MEL is soliciting proposals for the development of methods, metrics, and tools for the evaluation of conceptual models. The evaluation should be approached from two perspectives:

1. A high-quality conceptual model will yield high-quality data. The operational evaluation of a data model will use data quality methods and application testing to evaluate the quality of conceptual models. Different classifications of applications may require different characteristics of the conceptual model.

2. A high-quality conceptual model will reflect the requirements of the domain. The developmental evaluation will develop methods and metrics for assessing the quality of the model with respect to the stakeholder requirements of the model. Methods will include negotiation and mediation mechanisms for resolving and reconciling conflicting perspectives held by stakeholders.

References:

Batini, C., Deri, S., and Navathe, S., “Conceptual Database Design, an Entity-Relationship Approach.” Benjamin/Cummings, Redwood City, 1992. ISBN 0-8053-0244-1.

Bruce, T.A., “Designing Quality Databases with IDEF1X Information Models.” Dorset House Publishing, New York, 1992. ISBN 0-932633-18-8.

Henderson-Sellars, B., “Object-oriented Metrics : Measures of Complexity.” Prentice Hall PTR, Upper Saddle River, NJ, 1996. ISBN 0-13-239872-9.

Humphreys, W.S., “Managing the Software Process.” The SEI Series in Software Engineering, N. Haberman, ed. Addison-Wesley, Reading, Massachusetts, 1989. ISBN 0-201-18095-2.

Krogstie, J., Lindland, O.I., and Sindre, G., "Defining Quality Aspects for Conceptual Models." Proceedings of the IFIP8.1 Working Conference on Information Systems Concepts (ISCO3): Towards a Consolidation of Views, Marburg, Germany, 1995.

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Ottman, B., West, M., and Fyfe, S., "Reviewing and Improving Data Models, The Data Management Guide." Shell Internationale Petroleum Maatschappil B.V., The Hague, 1992.

Parsons, J. and Wand, Y., "Choosing Classes in Conceptual Modeling." Communications of the ACM, 40, 6, pp. 63-69, 1997.

Pohl, K., "The Three Dimensions of Requirements Engineering: A Framework and Its Applications." Information Systems, 19, 3, pp. 243-258, 1994.

Reingruber, M. and Gregory, W.W., "The Data Modeling Handbook: A Best-practice Approach to Building Quality Data Models." John Wiley & Sons, 1994. ISBN 0-471-05290-6.

Rishe, N., "Database Design: The Semantic Modeling Approach." McGraw-Hill, New York, 1992. ISBN 0-07-052955-8.

Shanks, G. and Darke, P. "Quality in Conceptual Modeling: Linking Theory and Practice." Found c. March 1997.

Strong, D.M., Lee, Y.W., and Wang, R.W., "Data Quality in Context." Communications of the ACM, 40, 5, pp. 103-110, 1997.

West, M., ed., "Developing High Quality Data Models." Vol. 1. Shell International Petroleum Company Limited, London, 1994.

West, M., ed., "Developing High Quality Data Models." Vol. 2. Shell International Petroleum Company Limited, London, 1994.

West, M., ed., "Developing High Quality Data Models." Vol. 3. Shell International Petroleum Company Limited, London, 1994.

8.22.4T Subtopic: Ontological Engineering Applied to Manufacturing System Integration Research

The Manufacturing Engineering Laboratory is soliciting proposals for the application of the principles behind ontological engineering towards the area of manufacturing systems integration and/or research. The result of this effort will either be: (1) mechanisms, infrastructures, and/or methodology tools with an ontological underpinning that will facilitate the interoperability of manufacturing systems; or (2) the application of ontological principles towards the creation of an electronic notebook, as described below. Within the former area, these principles may be applied to information that is to be shared among manufacturing applications, including, but not limited to, process, resource, product, and design information. Special emphasis will be given to proposals that are applicable to multiple types of information.

The implementation of an ontology-based electronic notebook system (option 2) should allow researchers to collaborate, build, and review domain-specific ontologies and knowledge bases. The implemented system should demonstrate its applicability to a collaborative engineering or manufacturing setting. Each ontology and associated knowledge base(s) [the data] is inherently domain-specific. However the electronic notebook system itself should be domain independent. The system must be based on knowledge representation and interchange formats, which permit interaction and possible integration with other such knowledge systems, e.g. KQML and KIF. The use of agent technology is recommended to coordinate and integrate cooperating researchers' electronic notebook entries, and to facilitate integration with other knowledge systems. The user interface(s) should be platform-independent, and other system components should be platform portable. It is expected that a proposed system should leverage prior work in the field of electronic notebooks.

In the context of this proposal, an ontology is an explicit treatment of some topic. It is a formal and declarative representation, which includes the vocabulary (or names) for the terms in that subject area and the logical statements that describe what the terms mean and how they can or cannot be related to each other. Ontologies, therefore, provide a formal means for representing and communicating knowledge about some topic and a set of relationships that hold among the terms. Without these formal and concise definitions of attributes, relations, and concepts, usually built upon some type of foundational theory, integration of manufacturing applications runs the risk of misinterpretation of those concepts, leading to problems with interoperability and exchange.

References:

Knowledge Sharing Effort, Internet site: http://www.cs.umbc.edu/kse/.

Ontolingua Server Project, The, Internet site: http://ksi.cpsc.ucalgary.ca/KAW/KAW96/farquhar/farquhar.html.

Plan Ontology Project, Internet site: http://www.aiai.ed.ac.uk/~bat/ontology.html.

Process Interchange Format, Internet site: http://soa.cba.hawaii.edu/pif/.

Toronto Virtual Enterprise Project, Internet site:
http://www.ie.utoronto.ca/EIL/tove/ontoTOC.html.

9.0 SUBMISSION FORMS

Proposal to the Department of Commerce
COVER PAGE

PROGRAM	This firm and/or Principal Investigator ____ has ____ has not submitted proposals for essentially equivalent work under other federal program solicitations, or ____ has ____ has not received other federal awards for essentially equivalent work.
SBIR – SMALL BUSINESS INNOVATION RESEARCH	

SOLICITATION NO.:	CLOSING DATE:
DOC 99-1	January 13, 1999

NAME OF SUBMITTING FIRM

ADDRESS OF FIRM (INCLUDE ZIP CODE)

TITLE OF PROPOSED PROJECT

REQUESTED AMOUNT	PROPOSED DURATION
$	**6 months**

SOLICITATION SUBTOPIC NO.	SOLICITATION SUBTOPIC TITLE

THE ABOVE ORGANIZATION CERTIFIES THAT:	YES	NO
1. It is a small business firm as defined on page 3.		
2. The primary employment of the principal investigator will be with this firm at the time of award and during the conduct of the research.		
3. A minimum of two-thirds of research will be performed by this firm in Phase 1.		
4. It qualifies as a minority and disadvantaged small business as defined on page 3.*		
5. It qualifies as a woman-owned small business as defined on page 4.*		
6. It will permit the government to disclose the title and technical abstract page, plus the name, address and telephone number of the corporate official if the proposal does not result in an award to parties that may be interested in contacting you for further information or possible investment.		

PRINCIPAL INVESTIGATOR/ PROJECT DIRECTOR	CORPORATE OFFICIAL (BUSINESS)	OTHER INFORMATION
NAME	NAME	YEAR FIRM FOUNDED
SIGNATURE	SIGNATURE	NUMBER OF EMPLOYEES Avg. Previous 12 mos. _____ Currently _____
TITLE	TITLE	HAS THIS PROPOSAL BEEN SUBMITTED TO ANOTHER AGENCY? Yes _____ No _____
DATE TELEPHONE NO. + AREA CODE	DATE TELEPHONE NO. + AREA CODE	IF YES, WHAT AGENCY?

* For statistical purposes only

PROPRIETARY NOTICE

For any purpose other than to evaluate the proposal, this data shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a funding agreement is awarded to this proposer as a result of or in connection with this submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Goverment's right to use information contained in the data source without restriction. The data in this proposal subject to this restriction is contained on separate proprietary page(s).

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9.0 SUBMISSION FORMS

Department of Commerce
Small Business Innovation Research Program
PROJECT SUMMARY

NAME OF FIRM	AMOUNT REQUESTED
ADDRESS	PHONE # FAX #
PRINCIPAL INVESTIGATOR (NAME AND TITLE)	
TITLE OF PROJECT	
SOLICITATION SUBTOPIC NO.	SOLICITATION SUBTOPIC TITLE
TECHNICAL ABSTRACT (LIMIT TO 200 WORDS)	
POTENTIAL COMMERCIAL APPLICATIONS OF THE RESEARCH	

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Intentionally Blank

SBIR PROPOSAL SUMMARY BUDGET

FIRM:	PROPOSAL NUMBER: (Leave Blank)

PRINCIPAL INVESTIGATOR:

	TOTAL PRICE
DIRECT LABOR:	$
OVERHEAD RATE:	$
OTHER DIRECT COSTS:	$
MATERIALS:	$
GENERAL AND ADMINISTRATIVE (G&A):	$
PROFIT:	$
TOTAL PRICE PROPOSED:	$

TYPED NAME AND TITLE: SIGNATURE:

THIS PROPOSAL IS SUBMITTED IN RESPONSE TO DOC SBIR PROGRAM SOLICITATION 99-1
AND REFLECTS OUR BEST ESTIMATES AS OF THIS DATE.

DATE SUBMITTED: _____

BUDGET INSTRUCTIONS

The offeror is to submit a cost estimate with detailed information for each element, consistent with the offeror's cost accounting system. This does not eliminate the need to fully document and justify the amounts requested in each category. Such documentation should be contained, as appropriate, on a budget explanation page immediately preceding the budget in the proposal.

1. Principal Investigator (PI).

The PI must be with the small business concern at the time of contract award and during the period of performance of the research effort. Additionally, more than half of the PI's time must be spent with the small business firm during the contract performance.

2. Direct Labor.

All personnel (including PI) must be listed individually, with the projected number of hours and hourly wage.

3. Overhead Rate.

Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable overhead rate may be requested, which will be subject to approval by DOC.

4. Other Direct Costs.

List all other direct costs which are not described above (i.e. consultants, subcontractor, travel, and equipment purchases). Each of the above needs a detailed explanation and elaboration of its relation to the project.

5. Materials.

The materials and supplies required for the project must be identified. There is also a need to specify type, quantity, unit cost, and total estimated cost of these materials and supplies.

6. General & Administration (G&A).

Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable G&A rate may be requested, which will be subject to approval by DOC.

7. Profit.

The small business may request a reasonable profit (about 7 percent of costs is the average proposed).

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CHECKLIST OF REQUIREMENTS

Please review this checklist carefully to assure that your proposal meets the DOC SBIR requirements. Failure to meet these requirements may result in your proposal being returned without consideration. Seven copies of the proposal must be received at DOC by Noon EST January 13, 1999.

_____ 1. The proposal is 25 PAGES OR LESS in length.

_____ 2. The proposal is limited to only ONE of the subtopics in Section 8.

_____ 3. The proposal budget is for $75,000 or LESS (or $50,000 or less for those topics designated as "SG"). No more than one-third of the budget goes to consultants and/or subcontractors.

_____ 4. The abstract contains no proprietary information and does not exceed space provided on the Project Summary.

_____ 5. The proposal contains only pages of 21.6cm X 27.9cm size (8 ½" X 11").

_____ 6. The proposal contains an easy-to-read font (fixed pitch of 12 or fewer characters per inch or proportional font of point size 10 or larger) with no more than 6 lines per inch, except as a legend on reduced drawings, but not tables.

_____ 7. The COVER PAGE has been completed and is PAGE 1 of the proposal.

_____ 8. The PROJECT SUMMARY has been completed and is PAGE 2 of the proposal.

_____ 9. The TECHNICAL CONTENT of the proposal begins on PAGE 3 and includes the items identified in SECTION 3.3.3 of the solicitation.

_____ 10. The SBIR PROPOSAL SUMMARY BUDGET has been completed and is the LAST PAGE of the proposal.

_____ 11. The P.I. is employed by the company.

NOTE: Proposers are cautioned to be careful of unforeseen delays that can cause late arrival of proposals at DOC, with the result that they may be returned without evaluation.

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BOSTON, MA **NOVEMBER 3-5, 1998**

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